Department for
Energy Security
& Net Zero

2025 GOVERNMENT GREENHOUSE GAS CONVERSION FACTORS FOR COMPANY REPORTING

Methodology Paper for Conversion Factors
Final Report

June 2025

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Glossary

Abbreviation	Definition
ANPR	Automatic Number Plate Recognition
BEV	Battery electric vehicle
CAA	Civil Aviation Authority
CBS	National Bureau for Statistics in the Netherlands
CEF	Carbon emission factor
CH_4	Methane
CHP	Combined Heat and Power
CHPQA	Combined Heat and Power Quality Assurance
CNG	Compressed natural gas
CO_2	Carbon dioxide
DfT	Department for Transport
DUKES	Digest of UK Energy Statistics
EEA	European Environment Agency
EF	Emission factor
ETS	Emissions Trading System
FAME	Fatty Acid Methyl Ester
GCV	Gross calorific value
GHG	Greenhouse gas
GVW	Gross vehicle weight
GWP	Global Warming Potential
HGVs	Heavy goods vehicles
IPCC	Intergovernmental Panel on Climate Change
LCA	Life cycle assessment

Abbreviation	Definition
LGVs	Light goods vehicles
LPG	Liquefied petroleum gas
MRF	Material recovery facility
MTBE	Methyl tert-butyl ether
NAEI	National Atmospheric Emissions Inventory
NCV	Net calorific value
NEDC	New European Driving Cycle
N_2O	Nitrous oxide
ORR	Office of Rail and Road
PHEV	Plug-in hybrid electric vehicle
RF	Radiative forcing
RoPax	Roll on/roll off a passenger
RTE	French transmission system operator
RTFO	Renewable Transport Fuel Obligation
RW	Real-world
SEAI	Sustainable Energy Authority of Ireland
SECR	Streamlined Energy and Carbon Reporting
SMMT	Society of Motor Manufacturers and Traders
T&D	Transmission & Distribution
TfL	Transport for London
TTW	Tank-To-Wheel (i.e. direct emissions at the point of use)
UK GHGI	UK’s Greenhouse Gas Inventory
UNFCCC	United Nations Framework Convention on Climate Change
WLTP	Worldwide Harmonised Light Vehicle Test Procedure
WTT	Well-To-Tank (i.e. upstream emissions from the production of fuel or electricity)

Abbreviation	Definition
WTW	Well-To-Wheel (= Well-To-Tank + Tank-To-Wheel)
xEV	Generic term for battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), range-extended electric vehicles (REEV) and fuel cell electric vehicles (FCEV)

1. General Introduction

1.1. Greenhouse gases (GHGs) can be measured by recording emissions at source, by continuous emissions monitoring or by estimating the amount emitted using activity data (such as the amount of fuel used) and applying relevant conversion factors (e.g. calorific values, emission factors, etc.).

1.2. These conversion factors allow organisations and individuals to calculate GHG emissions from a range of activities, including energy use, water consumption, waste disposal and recycling, and transport activities. For instance, a conversion factor can be used to calculate the amount of GHG emitted as a result of burning a particular quantity of oil in a heating boiler.

1.3. Chapters 2 to 15 present the conversion factors for a single type of emissions-releasing activity (for example, using electricity or driving a passenger vehicle). These emissions-releasing activities are categorised into three groups known as scopes. Each activity is listed as either Scope 1, Scope 2 or Scope 3.

a) Scope 1 (direct) emissions are those from activities owned or controlled by your organisation. Examples of Scope 1 emissions include emissions from combustion in owned or controlled boilers, furnaces and vehicles; and emissions from chemical production in owned or controlled process equipment.
b) Scope 2 (energy indirect) emissions are those released into the atmosphere that is associated with the consumption of purchased electricity, heat, steam and cooling. These indirect emissions are a consequence of an organisation's energy use but occur at sources the organisation does not own or control.
c) Scope 3 (other indirect) emissions are a consequence of your actions that occur at sources an organisation does not own or control and are not classed as Scope 2 emissions. Examples of Scope 3 emissions are business travel by means not owned or controlled by an organisation, waste disposal, materials or fuels that an organisation purchase. Deciding if emissions from a vehicle, office or factory that you use are Scope 1 or Scope 3 may depend on how organisations define their operational boundaries. Scope 3 emissions can be from activities that are upstream or downstream of an organisation. More information on Scope 3 and other aspects of reporting can be found in the Greenhouse Gas Protocol Corporate Standard[1].

1.4. The 2025 UK Government Greenhouse Gas Conversion factors for Company Reporting[2] (hereafter the 2025 UK GHG Conversion factors) represent the current official set of UK government conversion factors. These factors are also used in a number of different policies.

[1] https://ghgprotocol.org/corporate-standard

[2] Previously known as the 'Guidelines to Defra/DECC's GHG Conversion factors for Company Reporting'.

1.5. The UK GHG Conversion Factors have been developed as part of the NAEI (National Atmospheric Emissions Inventory) contract, managed by Ricardo, which includes the:

a) UK Air Quality Pollutant Inventory (AQPI)
b) UK Greenhouse Gas Inventory (GHGI)

1.6. The UK GHGI for 2023 (Ricardo, 2025) is available at: https://naei.energysecurity.gov.uk/reports/uk-greenhouse-gas-inventory-1990-2023-annual-report-submission-under-framework-convention

1.7. Values for the non-carbon dioxide (CO_2) GHGs, methane (CH_4) and nitrous oxide (N_2O), are presented as CO_2 equivalents (CO_2e), using Global Warming Potential (GWP) factors from the Intergovernmental Panel on Climate Change (IPCC)'s fifth assessment report (IPCC, 2014)(GWP for CH_4 = 28, GWP for N_2O = 265). This is consistent with reporting under the United Nations Framework Convention on Climate Change (UNFCCC) and consistent with the UK GHGI, upon which the 2025 GHG Conversion Factors are based. Although the IPCC has prepared a newer version, the methods have not yet been officially accepted for use under the UNFCCC.

1.8. The 2025 GHG Conversion Factors are for use with activity data that falls entirely or mostly within 2025. The factors will continue to be improved and updated on an annual basis with the next publication in June 2026. Further information about the 2025 GHG Conversion factors together with previous methodology papers is available at: https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting.

1.9. It is important to note that the primary aim of this methodology paper is to provide information on the methodology used in creating the UK Government GHG Conversion factors for Company Reporting. This report provides the methodological approach, the key data sources and the assumptions used to define the conversion factors provided in the 2025 GHG Conversion factors. The report aims to expand and complement the information already provided in the data tables themselves. However, it is not intended to be an exhaustively detailed explanation of every calculation performed (this is not practical/possible), nor is it intended to provide guidance on the practicalities of reporting for organisations. Rather, the intention is to provide an overview with key information so that the basis of the conversion factors provided can be better understood and assessed.

1.10. Detailed guidance on how the conversion factors provided should be used is contained in the "Introduction" worksheet of the 2025 GHG Conversion factors set. This guidance must be referred to before using the conversion factors and provides important context for the description of the methodologies presented in this report and in the table footnotes.

Overview of major changes since the previous update

1.11. Major changes and updates in terms of methodological approach from the 2025 update are summarised below. All other updates are essentially revisions of the previous year's data based on new/improved data whilst using existing calculation methodologies (i.e. using a similar methodological approach as for the 2024 update):

a) There are major changes to the Air transport factors in the 2025 update, principally due to the impact of post-covid recovery on load factors. In the previous 2023 update of air transport factors (based on 2021 data), load factors were significantly reduced due to the impacts of the COVID-19 pandemic. Other changes result from the improvement which makes use of new publicly available Civil Aviation Authority (CAA) data (described below) and revisions to the EUROCONTROL small emitters tool.

b) There was an improvement in the 2025 update to use new publicly available data from CAA to replace the old 2012 data sets from CAA. Prior to 2025 update, confidential 2012 CAA data were still being used to estimate detailed breakdowns of flight activity, including number of flights, flight km, seat km, number of passengers, total tonnes km available (passengers plus cargo), freight tonnes km used, mail tonnes km used, passenger tonnes km used, and total cargo uplifted, broken down by Aircraft type, and Sector (Domestic, European Economic Area (EEA), and other international). This information was used to (i) apportion flights, flight km, and tonne km between domestic, short haul, and long haul, (ii) provide cargo capacity, and load factors, and (iii) apportion CO_2 emissions from passenger flights between passengers and freight. However, the 2012 data were provided confidentially and there is no up-to-date dataset which is in the same format. The 2025 update has therefore introduced an improvement by replacing the older 2012 data sets from CAA with new publicly available data from CAA, to enhance transparency and enable regular updates with the up-to-date fleet data. As a result of this improvement, there are changes, particularly affecting freight flights factors.

c) Incineration with energy recovery: This category was named 'combustion' in previous years. It has been renamed to clarify that energy recovery is assumed to take place. The emissions attributed to the company which generates the waste cover only the collection of waste from their site and deposit at the first point of processing. The emissions from combustion would be zero for the reporting organisation, as those emissions would instead be allocated to the end user of the energy. At present there is no factor for incineration without energy recovery, but this may be added in future years.

d) For the waste disposal factors, updates have been made to the assumptions relating to mechanical sorting, which reflect differences in grid intensity and power usage in material recovery facilities. The previous mechanical sorting factor (3.44) has been replaced with a new mechanical sorting factor (1.64) which is taken from ‘Analysis of material recovery facilities for use in life-cycle assessment’ (Pressley & al, 2015). This update has had impacts on open loop, closed loop and incineration with energy recovery factors which show a substantial proportional decrease in emissions per tonne, although in absolute terms the change is smaller (c. 2kg per tonne).

Conversion factors update frequency

1.12. The scope of the conversion factors has expanded over time (mainly due to the addition of new factors and an increased QA burden). In light of this, a risk-based approach has been adopted which focuses on delivering accurate conversion factors for high-emitting UK sources that vary over time, and reflect changes in key sources for most companies, including electricity, natural gas, waste management, road transport fuels and fleet. However, less focus has been invested on conversion factors for minor sources and minor pollutants, where no or little new reference data exists and / or where there is little variation over time. In these areas, the frequency of updating the conversion factor reflects the level of risk associated with retaining an historical value.

1.13. The conversion factors for high-emitting UK sources vary over time, reflect changes in key sources for most companies and are therefore updated annually or periodically. In this latest release, the Conversion Factors that are updated to reflect latest UK evidence (for example on fuel mix, transport fleet, vehicle utilisation) include CO_2 and CO_2e factors for:

- Fuels: natural gas, diesel, petrol, coal, CNG and LNG
- Bioenergy
- Electricity use
- Passenger vehicles, delivery vehicles, and business travel: cars, HGVs, LGVs, xEVs & buses
- Water supply and Water treatment[3]
- Material Use & Waste disposal
- Outside of scopes[4]
- Aviation
- Heat & steam

1.14. Conversion factors that have been held constant from the 2023 release (aligned with AR5 GWPs values):

- Refrigerants[5]

1.15. Conversion factors that have been held constant from the 2022 release include:

- Homeworking (held constant but aligned with AR5 GWPs values)
- Hotel stay

[3] Water Supply & Water Treatment factors are to be updated only when new data is available. In the 2025 update, the factors are fully updated.

[4] The UK electricity out of scopes factor remained constant from the 2022 release as part of the factors update frequency arrangement.

[5] For Refrigerants & other process gases, almost all values have been updated to use AR5 GWPs (and where AR5 values were not available, but AR6 values were, AR6 GWPs were used).

1.16. Conversion factors that have been held constant since the 2021 release (they were in the AR4 basis) but are now aligned with AR5 GWPs, include:

- All methane (CH_4) and nitrous oxide (N_2O) conversion factors
- Fuels: butane, LPG, other petroleum gas, propane, aviation spirit, aviation turbine fuel, burning oil, gas oil, fuel oil, lubricants, naphtha, processed fuel oils - residual oil, processed fuel oils - distillate oil, refinery miscellaneous, waste oils, marine gas oil, marine fuel oil, coking coal, petroleum coke
- Passenger vehicles and business travel: taxis, motorcycles, rail, shipping
- Well-to-Tank factors[6]

1.17. Table 1 shows a summary of which factors are still in an AR4 basis and which have been aligned to AR5 GWPs. These details are covered in “summary of changes since the previous update” in their sections.

Table 1: summary of conversion factors that are in AR4 or/and AR5 basis GWPs

	In AR4 basis	In AR5 basis
Fuel		✓
WTT Fuel		✓
UK electricity		✓
Transmission & Distribution		✓
WTT UK electricity		✓
WTT Transmission & Distribution		✓
Heat & Steam		✓
WTT Heat & Steam		✓
Refrigerant and Processes[7]		✓
Passenger Land Transport		✓
WTT Passenger Land Transport		✓
Freight Land Transport		✓
WTT Freight Land Transport		✓
Sea Transport		✓
WTT Sea Transport		✓
Air Transport		✓

[6] WTT Bioenergy factors are still based on a AR4 basis.

[7] For Refrigerants & other process gases, almost all values have been updated to use AR5 GWPs (and where AR5 values were not available, but AR6 values were, AR6 GWPs were used).

	In AR4 basis	In AR5 basis
WTT Air Transport		✓
Bioenergy	✓	
WTT Bioenergy	✓	
Water Supply & Treatment		✓
Hotel Stay[8]	✓	✓
Material Use	✓	
Waste Disposal		✓
Homeworking		✓

[8] Hotel Stay conversion factors are not all aligned with the AR5 GWPs, because the data from Hotel Sustainability Benchmarking Index 2021 were in CO_2e with no breakdown of CH_4 and N_2O emissions. The conversion factors of different countries could be in either AR4 or AR5 basis, depending on the GWPs used by the reporting hotels if the data were reported in CO_2e instead of the raw values of CO_2, CH_4 and N_2O emissions.

2. Fuel Emission Factors

Section summary

2.1. The fuels conversion factors should be used for primary fuel sources combusted at a site or in an asset owned or controlled by the reporting organisation. Well-to-tank (WTT) factors should be used to account for the upstream Scope 3 emissions associated with extraction, refining and transportation of the raw fuel sources to an organisation's site (or asset), prior to their combustion.

2.2. The fuel properties can be used to determine the typical calorific values/densities of the most common fuels. The fuel properties should be utilised to change units of energy, mass, volume, etc. into alternative units; this is particularly useful where an organisation is collecting data in units of measure that do not have a fuel conversion factor that can be directly used to determine a carbon emission total. where the related worksheets to fuel conversion factors are available in the online spreadsheets of the UK GHG Conversion factors.

2.3. Table 2 shows where the related worksheets to fuel conversion factors are available in the online spreadsheets of the UK GHG Conversion factors.

Table 2: Related worksheets to the fuel conversion factors

Worksheet name	Full set	Condensed set
Fuels	Y	Y
WTT – fuels	Y	N
Fuel properties	Y	Y
Conversions	Y	Y

Summary of changes since the previous update

2.4. No methodological updates have been made to the calculation of conversion factors for fuels in the 2025 update.

Direct Emissions

2.5. Fuel conversion factors for direct emissions presented in the 2025 GHG Conversion factors are based on the conversion factors used in the UK GHGI for 2023 (Ricardo, 2025).

2.6. The CO_2 emissions factors are based on the same factors used in the UK GHGI and are essentially independent of application as they assume that all fuel is fully oxidised and combusted. These factors have been updated for natural gas, coal, petrol and diesel to be in line with the latest UK GHGI. Emissions of CH_4 and N_2O

can vary to some degree for the same fuel depending on the use (e.g. conversion factors for gas oil used in rail, shipping, non-road mobile machinery or different scales/types of stationary combustion plants can all be different). The figures for fuels in the 2025 GHG Conversion factors are based on an activity-weighted average of all the different CH_4 and N_2O conversion factors from the 2023 GHGI.

2.7. The majority of conversion factors from the GHGI are on a net energy basis (t/TJ), and have been converted into different energy, volume and mass based units using the information on Gross and Net Calorific Values (CV) (see definition of Gross CV and Net CV in the footnote below[9]) used in the GHGI or for some fuels, DESNZ's Digest of UK Energy Statistics (DUKES) (DESNZ, 2024).

2.8. There are three tables in the 2025 GHG Conversion factors, the first of which provides conversion factors for gaseous fuels, the second for liquid fuels and the final table provides the conversion factors for solid fuels.

2.9. When making calculations based on energy use, it is important to check (e.g. with your fuel supplier) whether these values were calculated on a Gross CV or Net CV basis and use the appropriate factor. Natural gas consumption figures quoted in kilowatt hours (kWh) by suppliers in the UK are generally calculated (from the volume of gas used) on a Gross CV basis (National Grid, 2021). Therefore, the emission factor for energy consumption on a Gross CV basis should be used by default for calculation of emissions from natural gas in kWh, unless your supplier specifically states they have used Net CV basis in their calculations instead.

2.10. When using the direct conversion factor for aviation turbine fuel, applying a 1.7 multiplier to the CO_2 is applicable to account for the radiative forcing effects of emissions at altitude. Further explanation of this is provide in Section 88.40.

Indirect/WTT Emissions from Fuels

2.11. These fuel lifecycle emissions (also sometimes referred to as 'Well-To-Tank', or simply WTT, emissions usually in the context of transport fuels) are the emissions 'upstream' from the point of use of the fuel. They result from the extraction, transport, refining, purification or conversion of primary fuels to fuels for direct use by end-users and the distribution of these fuels. They are classed as Scope 3 according to the GHG Protocol.

2.12. For the upstream conversion factors relating to diesel, petrol, kerosene, natural gas, CNG, and LNG, data are taken from a study by Exergia (Exergia et al., 2015); please refer to Table 5 for definitions of acronyms. As the Exergia report (Exergia et al., 2015) does not estimate upstream emissions for other fuels the JEC Well-To-Wheels study is used for coal, LPG, and lubricants; data are taken from (JEC WTW v5, 2020) as this is the most recent update for this source. Data

[9] Gross CV or higher heating value (HHV) is the CV under laboratory conditions. Net CV or lower heating value (LHV) is the useful calorific value in typical real-world conditions (e.g. boiler plant). The difference is essentially the latent heat of the water vapour produced (which can be recovered in laboratory conditions).

for naphtha is taken from an older version of the JEC report (JEC WTW v4a, 2014) because it is not present in the most recent update.

2.13. For fuels covered by the 2025 GHG Conversion factors where no fuel lifecycle emission factor was available in either source, these were estimated based on similar fuels, according to the assumptions in Table 5.

2.14. WTT emissions for petrol, diesel and kerosene in the Exergia study (Exergia et al., 2015), used within the 2025 GHG Conversion factors set, are based on:

- Detailed modelling of upstream emissions associated with 35 crude oils used in EU refining, which accounted for 88% of imported oil in 2012.
- Estimates of the emissions associated with the transport of these crude oils to EU refineries by sea and pipeline, based on the location of ports and refineries.
- Emissions from refining, modelled on a country by country basis, based on the specific refinery types in each country. An EU average is then calculated based on the proportion of each crude oil going to each refinery type.
- An estimate of emissions associated with imported finished products from Russia and the US.

2.15. Conversion factors are also calculated for diesel as supplied at public and commercial refuelling stations, by factoring in the WTT component due to biodiesel supplied in the UK as a proportion of the total supply of diesel and biodiesel (3.02% by unit volume, 2.81% by unit energy – see Table 3). These estimates have been made based on the Department for Transport Renewable Fuel Statistics (DfT, 2024).

2.16. Conversion factors are also calculated for petrol as supplied at public and commercial refuelling stations, by factoring in the bioethanol supplied in the UK as a proportion of the total supply of petrol and bioethanol (8.37% by unit volume, 5.54% by unit energy – see Table 3). These estimates have also been made based on Department for Transport Renewable Fuel Statistics (DfT, 2024).

Table 3: Liquid biofuels for transport consumption

	Total Sales, millions of litres		Biofuel % Total Sales		
	Biofuel	Conventional Fuel	per unit mass	per unit volume	per unit of energy
Diesel/Biodiesel	821	26,363	3.23%	3.02%	2.81%
Petrol/Bioethanol	1,442	15,788	8.90%	8.37%	5.54%

Source: Department for Transport, Table RTFO 01. Data used here is from the Renewable fuel statistics 2024 Third provisional tables

2.17. Emissions for natural gas, LNG and CNG, used within the 2025 GHG Conversion factors, are based on (Exergia et al., 2015):

a) Estimates of emissions associated with supply in major gas producing countries supplying the EU. These include both countries supplying piped gas and countries supplying LNG.

b) The pattern of gas supply for each Member State (based on IEA data for natural gas supply in 2012).

c) Combining the information on emissions associated with sources of gas, with the data on the pattern of gas supply for each Member State, including the proportion of LNG that is imported.

d) For parts of the natural gas supply chain which occur in the UK (transmission and distribution and dispensing of CNG), data from DUKES (DESNZ, 2024) is used to update the emissions for these activities estimated in Exergia.

2.18. The methodology developed allows for the value calculated for gas supply in the UK to be updated annually This allows changes in the sources of imported gas, particularly LNG, to be reflected in the emissions value.

2.19. Information on quantities and source of imported gas are available annually from DUKES[10] (DESNZ, 2023a) and can be used to calculate the proportion of gas in UK supply coming from each source. These can then be combined with the emissions factors for gas from each source from the EU study (Exergia et al., 2015), to calculate a weighted emissions factor for UK supply.

2.20. The methodology for calculating the WTT conversion factors for natural gas and CNG is different to the other fuels as it considers the increasing share of UK gas supplied via imports of LNG (which have a higher WTT emission factor than conventionally sourced natural gas) in recent years. Table 4 provides a summary of the information on UK imports of LNG and their significance compared to other sources of natural gas used in the UK grid. Small quantities of imported LNG are now re-exported, so a value for net imports is used in the methodology. The figures in Table 4 have been used to calculate the revised figures for Natural Gas and CNG WTT conversion factors provided in Table 5 below.

Table 4: Imports of LNG into the UK as a share of imports and net total natural gas supply

Year	LNG % of total natural gas imports (1)	Net Imports as % total UK supply of natural gas (2)	LNG Imports as % total UK supply of natural gas
2011	46.0%	43.7%	**29.5%**
2012	27.1%	49.2%	**17.5%**
2013	19.1%	51.7%	**12.1%**
2014	26.0%	46.3%	**15.9%**
2015	30.2%	43.4%	**18.8%**
2016	19.8%	48.2%	**11.6%**
2017	13.0%	46.7%	**7.7%**
2018	14.3%	48.0%	**8.2%**
2019	36.9%	49.1%	**21.7%**

[10] From Table 4.1 Commodity balances for natural gas and Table 4.5 Natural gas imports and exports, DUKES 2023

Year	LNG % of total natural gas imports (1)	Net Imports as % total UK supply of natural gas (2)	LNG Imports as % total UK supply of natural gas
2020	41.8%	45.6%	**24.7%**
2021	28.5%	57.5%	**18.8%**
2022	44.9%	46.0%	**35.5%**
2023	42.6%	45.5%	30.0%

Source: DUKES 2023, (1) Table 4.5 - Natural gas imports and exports; (DESNZ, 2024) and (2) Table 4.1 - Commodity balances

2.21. The final combined conversion factors, presented as kilograms of carbon dioxide equivalents per gigajoule on a net calorific value basis ($kgCO_2e/GJ$, Net CV basis), are listed in Table 5. These include WTT emissions of CO_2, N_2O and CH_4. These are converted into other units of energy (e.g. kWh, Therms) and to units of volume and mass using the default Fuel Properties and Unit Conversion factors also provided in the 2025 GHG Conversion factors alongside the emission factor data tables.

Table 5: Basis of the indirect/WTT emissions factors for different fuels

Fuel	Indirect/WTT EF ($kgCO_2e/GJ$, Net CV basis)	Source of Indirect/WTT Emission Factor	Assumptions
Aviation Spirit	18.3	Estimate	Similar to petrol
Aviation turbine fuel	15.1	Exergia, EM Lab and COWI, 2015	Emission factor for kerosene
Burning oil	15.1	Estimate	Same as Kerosene, as above
Butane	7.6	Estimate	Same as LPG
CNG	11.7	Exergia, EM Lab and COWI, 2015	Factors in UK % share LNG imports
Coal (domestic)	16.5	JEC WTW v5 (2019)	Emission factor for coal
Coal (electricity generation)	16.5	JEC WTW v5 (2019)	Emission factor for coal
Coal (industrial)	16.5	JEC WTW v5 (2019)	Emission factor for coal
Coal (electricity generation - home produced coal only)	16.5	JEC WTW v5 (2019)	Emission factor for coal
Coking coal	16.5	Estimate	Assume same as factor for coal
Diesel (100% mineral diesel)	17.5	Exergia, EM Lab and COWI, 2015	
Fuel oil	17.5	Estimate	Assume same as factor for diesel
Gas oil	17.5	Estimate	Assume same as factor for diesel

Fuel	Indirect/WTT EF ($kgCO_2e/GJ$, Net CV basis)	Source of Indirect/WTT Emission Factor	Assumptions
LPG	7.6	JEC WTW v5 (2019)	
LNG	20.0	Exergia, EM Lab and COWI, 2015	
Lubricants	27.3	JEC WTW v5 (2019)	
Marine fuel oil	17.5	Estimate	Assume same as factor for fuel oil
Marine gas oil	17.5	Estimate	Assume same as factor for gas oil
Naphtha	14.1	JEC WTW v5 (2019)	
Natural gas	9.3	Exergia, EM Lab and COWI, 2015	Factors in UK % share LNG imports
Other petroleum gas	6.5	Estimate	Based on LPG figure, scaled relative to direct emissions ratio
Petrol (100% mineral petrol)	18.3	Exergia, EM Lab and COWI, 2015	
Petroleum coke	11.9	Estimate	Based on LPG figure, scaled relative to direct emissions ratio
Processed fuel oils - distillate oil	26.4	Estimate	Based on lubricants figure
Processed fuel oils - residual oil	27.7	Estimate	Based on lubricants figure
Propane	7.6	Estimate	Same as LPG
Refinery miscellaneous	8.5	Estimate	Based on LPG figure, scaled relative to direct emissions ratio
Waste oils	26.5	Estimate	Based on lubricants figure

Notes:

(1) Burning oil is also known as kerosene or paraffin used for heating systems. Aviation Turbine fuel is a similar kerosene fuel specifically refined to a higher quality for aviation.
(2) CNG = Compressed Natural Gas is usually stored at 200 bar in the UK for use as an alternative transport fuel.
(3) Fuel oil is used for stationary power generation. Also, use this emission factor for similar marine fuel oils.
(4) Gas oil is used for stationary power generation and 'diesel' rail in the UK. Also, use this emission factor for similar marine diesel oil and marine gas oil fuels.
(5) LNG = Liquefied Natural Gas, usually shipped into the UK by tankers. LNG is usually used within the UK gas grid; however, it can also be used as an alternative transport fuel.

3. UK Electricity, Heat and Steam Emission Factors

Section summary

3.1. UK electricity conversion factors should be used to report on electricity used by an organisation at sites owned or controlled by them. This is reported as a Scope 2 (indirect) emission. The conversion factors for electricity are for the electricity supplied to the grid that organisations purchase – i.e. not including the emissions associated with the transmission and distribution of electricity. Conversion factors for transmission and distribution losses (the energy loss that occurs in getting the electricity from the power plant to the organisations that purchase it) are available separately and should be used to report the Scope 3 emissions associated with grid losses. WTT conversion factors for the UK and overseas electricity should be used to report the Scope 3 emissions of extraction, refining and transportation of primary fuels before their use in the generation of electricity.

3.2. Heat and steam conversion factors should be used to report emissions within organisations that purchase heat or steam energy for heating purposes or for the use in specific industrial processes. District heat and steam factors are also available. WTT heat and steam conversion factors should be used to report emissions from the extraction, refinement and transportation of primary fuels that generate the heat and steam organisations purchase.

3.3. Table 6 shows where the related worksheets to UK electricity and heat & steam conversion factors are available in the online spreadsheets of the UK GHG Conversion factors set.

Table 6: Related worksheets to UK electricity and heat & steam emission factors

Worksheet name	Full set	Condensed set
UK electricity	Y	Y
Transmission and distribution	Y	Y
WTT – UK Electricity	Y	N
Heat and steam	Y	N
WTT – heat and steam	Y	N

Summary of changes since the previous update

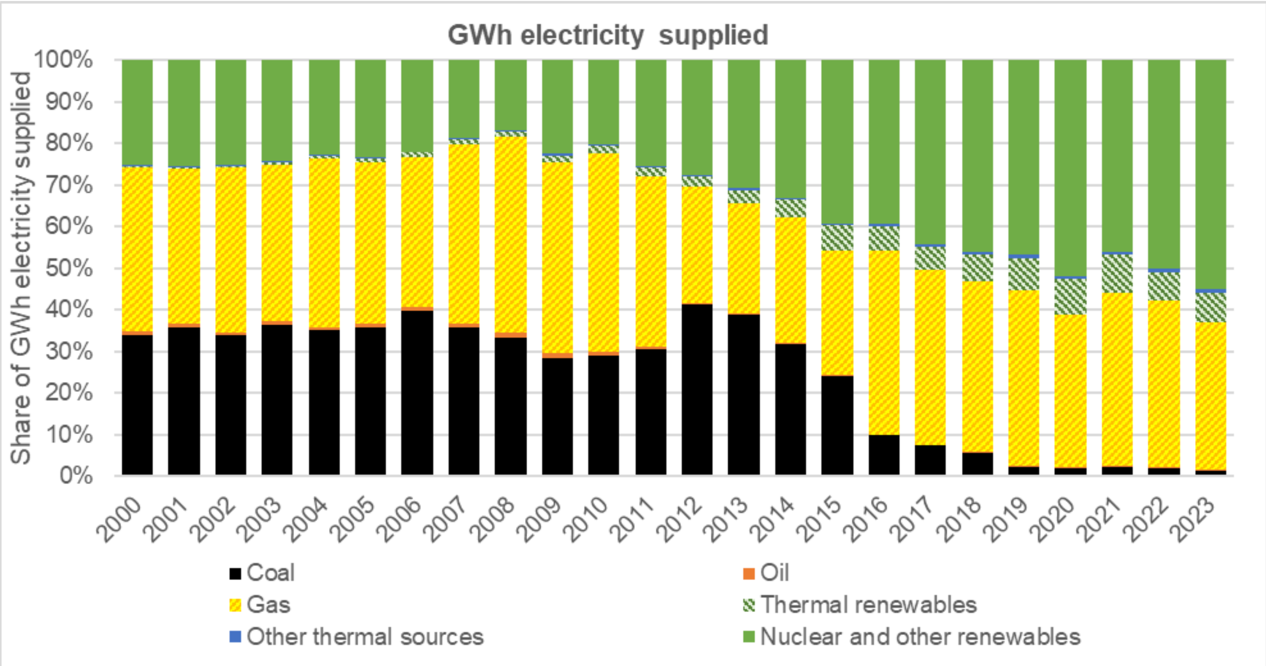
3.4. There have been no significant methodological changes since the previous update.

Direct Emissions from UK Grid Electricity

3.5. The electricity conversion factors given represent the average CO_2 emission from the UK national grid per kWh of electricity generated, classed as Scope 2 of the GHG Protocol and separately for electricity transmission and distribution losses, classed as Scope 3. The calculations also factor in net imports of electricity via the interconnectors with Ireland, the Netherlands, France, Belgium, and Norway. These factors include only direct CO_2, CH_4 and N_2O emissions at UK power stations and from autogenerators, plus those from the proportion of imported electricity. They do not include emissions resulting from production and delivery of fuel to these power stations (i.e. from gas rigs, refineries and collieries, etc.).

3.6. The UK grid electricity factor changes from year to year as the fuel mix consumed in UK power stations (and autogenerators) changes, and as the proportion of net imported electricity also changes. These annual changes can be large as they depend very heavily on the relative prices of coal and natural gas as well as fluctuations in peak demand and renewables. There has been a sustained decline in the amount of coal used for electricity generation over the past decade, with the last UK coal power station having closed in September 2024. The annual variability, and the recent trends in coal use, in UK electricity generation mix is illustrated in Figure 1 below.

Figure 1: Time series of the mix of UK electricity generation by type



Notes: The chart presents data for actual years; the emissions factors for a given GHG Conversion Factor update year correspond to the data for the actual year 2 years behind, i.e. the 2025 conversion factors are based on 2023 data.

3.7. The UK electricity conversion factors provided in the 2025 GHG Conversion factors are based on emissions from IPCC sectors 1A1ai (power stations) and 1A2b/1A2gviii (autogenerators) in the UK Greenhouse Gas Inventory (GHGI) for 2023 (Ricardo, 2025). These emissions from the GHGI only include autogeneration from coal and natural gas, and do not include emissions for electricity generated and supplied by autogenerators using oil or other thermal non-renewable fuels[11]. Estimates of the emissions arising from other fuels used for autogeneration have been made using standard GHGI emission factors, information from DUKES Table 5.6 (DESNZ, 2024), and DESNZ's DUKES team on the total fuel use (and shares by fuel type). The method also accounts for the share of autogeneration electricity that is exported to the grid, which varies significantly from year-to-year.

3.8. The UK is a net importer of electricity from the interconnectors with France, the Netherlands, Belgium, Norway and Denmark, and a net exporter of electricity to Ireland according to DUKES (DESNZ, 2024). For the 2025 GHG Conversion factors the total net electricity imports were calculated from DUKES Table 5.1.2 (Electricity supply, availability and consumption). The net shares of imported electricity over the interconnectors are calculated from data from DUKES Table 5A (Net Imports via interconnectors, GWh).

3.9. An average imported electricity emission factor is calculated from the individual factors for the relevant countries and weighted by their respective share of net imports. This average electricity emission factor – including losses – is used to account for the net import of electricity, as it will also have gone through the relevant countries' distribution systems. Note that this method effectively reduces the UK's electricity conversion factors as the resulting average net imported electricity emission factor is lower than that for the UK. This is largely because France's electricity generation is much less carbon-intensive than that of the UK, and accounts for the largest share of the net imports.

3.10. The source data and calculated emissions factors are summarised in Table 7, Table 8 and Table 9. Time series source data and conversion factors are fixed/locked from the 2024 GHG Conversion Factor update and for earlier years have been highlighted in light grey. The tables provide the data and conversion factors against the relevant data year. Table 7 also provides a comparison of how the data year reads across to the GHG conversion factors update/reporting year to which the data and conversion factors are applied, which is two years ahead of the data year. For example, the most recent emission factor for the 2025 GHG Conversion factors is based on the data year 2023.

3.11. Earlier years (those prior to the current update) are based on data reported in previous versions of DUKES and following the convention set from 2016 data year, historic time series factors/data have not been updated. Time series data in light grey is locked/fixed for the purposes of company reporting and has not been updated in the database in the 2025 GHG Conversion factors update.

3.12. A full-time series of data using the most recently available GHGI and DUKES datasets for all years is provided in Appendix 2 of this report. This is provided for purposes other than company reporting, where a fully consistent data time series is desirable, e.g. for policy impact analysis. This dataset also reflects the changes

[11] Other thermal non-renewable fuels include the following (with ~2024 update % share): blast furnace gas (~30%), chemical waste (~7%), coke oven gas (~4%) and municipal solid waste (MSW, ~59%)

in the methodological approach implemented for the 2016 update and is applied across the whole time series.

Table 7: Base electricity generation emissions data

Data Year	Applied to Reporting Year	Electricity Generation [1] GWh	Total Grid Losses [2] %	UK electricity generation emissions [3], ktonne		
				CO_2	CH_4	N_2O
1990	1992	290,666	8.08%	204,614	2.671	5.409
1991	1993	293,743	8.27%	201,213	2.499	5.342
1992	1994	291,692	7.55%	189,327	2.426	5.024
1993	1995	294,935	7.17%	172,927	2.496	4.265
1994	1996	299,889	9.57%	168,551	2.658	4.061
1995	1997	310,333	9.07%	165,700	2.781	3.902
1996	1998	324,724	8.40%	164,875	2.812	3.612
1997	1999	324,412	7.79%	152,439	2.754	3.103
1998	2000	335,035	8.40%	157,171	2.978	3.199
1999	2001	340,218	8.25%	149,036	3.037	2.772
2000	2002	349,263	8.38%	160,927	3.254	3.108
2001	2003	358,185	8.56%	171,470	3.504	3.422
2002	2004	360,496	8.26%	166,751	3.49	3.223
2003	2005	370,639	8.47%	177,044	3.686	3.536
2004	2006	367,883	8.71%	175,963	3.654	3.414
2005	2007	370,977	7.25%	175,086	3.904	3.55
2006	2008	368,314	7.21%	184,517	4.003	3.893
2007	2009	365,252	7.34%	181,256	4.15	3.614
2008	2010	356,887	7.45%	176,418	4.444	3.38
2009	2011	343,418	7.87%	155,261	4.45	2.913
2010	2012	348,812	7.32%	160,385	4.647	3.028
2011	2013	330,128	7.88%	148,153	4.611	3.039
2012	2014	320,470	8.04%	161,903	5.258	3.934
2013	2015	308,955	7.63%	146,852	4.468	3.595
2014	2016	297,897	8.30%	126,358	4.769	2.166

Data Year	Applied to Reporting Year	Electricity Generation (1) GWh	Total Grid Losses (2) %	UK electricity generation emissions (3), ktonne		
				CO_2	CH_4	N_2O
2015	2017	296,959	8.55%	106,209	7.567	2.136
2016	2018	297,203	7.85%	84,007	7.856	1.532
2017	2019	294,086	7.83%	74,386	7.588	1.353
2018	2020	289,120	7.92%	68,046	8.443	1.368
2019	2021	282,282	8.13%	60,504	9.158	1.321
2020	2022	269,804	8.39%	52,654	9.267	1.323
2021	2023	269,343	7.96%	57,803	9.808	1.396
2022	2024	286,902	8.12%	58,795	8.893	1.259
2023	2025	251,641	9.49%	46,974	9.657	1.327

Notes:

(1) **From 1990-2013 (data year)**: Based upon calculated total for centralised electricity generation (GWh supplied) from DUKES Table 5.5 Electricity fuel use, generation and supply for the year 1990 to 2014. The total is consistent with UNFCCC emissions reporting categories 1A1ai+1A2d includes (according to Table 5.5 categories) GWh supplied (gross) from all 'Major power producers'; plus, GWh supplied from thermal renewables + coal and gas thermal sources, hydro-natural flow and other non-thermal sources from 'Other generators'.

From 2014 (data year) onwards: based on the **total** for **all** electricity generation (GWh supplied) from DUKES Table 5.6, with a reduction of the total for autogenerators based on unpublished data from the BEIS (DESNZ) DUKES team on the share of this that is actually exported to the grid.

(2) Based upon calculated net grid losses from data in DUKES Table 5.1.2 (long term trends, only available online).

(3) **From 1990-2013 (data year)**: Emissions from UK centralised power generation (including Crown Dependencies only) listed under UNFCCC reporting category 1A1a and autogeneration - exported to the grid (UK Only) listed under UNFCCC reporting category 1A2f from the UK Greenhouse Gas Inventory for 2012 (Ricardo-AEA, 2014) for data years 1990-2012, and for 2013 (Ricardo Energy & Environment, 2015) for the 2013 data year.

From 2014 (data year) onwards: Excludes emissions from Crown Dependencies and also includes an accounting (estimate) for autogeneration emissions not specifically split out in the UK GHGI, consistent with the inclusion of the GWh supply for these elements also from 2014 onwards. Data is from the GHGI (Ricardo, 2025) for the 2022 data year.

Table 8: Base electricity generation conversion factors (excluding imported electricity)

Data Year	Emission Factor, kgCO_2e / kWh												% Net Electricity Imports
	For electricity GENERATED (supplied to the grid)				Due to grid transmission /distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	TOTAL
1990	0.70395	0.00019	0.00577	0.70991	0.05061	0.00001	0.00042	0.05104	0.76580	0.00021	0.00628	0.77229	**3.85%**
1991	0.68500	0.00018	0.00564	0.69081	0.04318	0.00001	0.00033	0.04352	0.74675	0.00019	0.00615	0.75309	**5.18%**
1992	0.64907	0.00017	0.00534	0.65458	0.05678	0.00002	0.00042	0.05722	0.70205	0.00019	0.00578	0.70801	**5.29%**
1993	0.58632	0.00018	0.00448	0.59098	0.05101	0.00002	0.00037	0.05140	0.63160	0.00019	0.00483	0.63662	**5.25%**
1994	0.56204	0.00019	0.00420	0.56643	0.04471	0.00002	0.00030	0.04502	0.62154	0.00021	0.00464	0.62639	**5.22%**
1995	0.53394	0.00019	0.00390	0.53803	0.03813	0.00001	0.00024	0.03839	0.58721	0.00021	0.00429	0.59170	**4.97%**
1996	0.50774	0.00018	0.00345	0.51137	0.04182	0.00002	0.00026	0.04210	0.55432	0.00020	0.00376	0.55828	**4.80%**
1997	0.46989	0.00018	0.00297	0.47304	0.03816	0.00002	0.00022	0.03840	0.50961	0.00019	0.00322	0.51302	**4.76%**
1998	0.46912	0.00019	0.00296	0.47226	0.04084	0.00002	0.00024	0.04111	0.51211	0.00020	0.00323	0.51555	**3.51%**
1999	0.43806	0.00019	0.00253	0.44077	0.04375	0.00002	0.00027	0.04404	0.47745	0.00020	0.00275	0.48041	**3.94%**
2000	0.46076	0.00020	0.00276	0.46372	0.04083	0.00002	0.00024	0.04109	0.50293	0.00021	0.00301	0.50616	**3.82%**
2001	0.47872	0.00021	0.00296	0.48189	0.04398	0.00002	0.00027	0.04427	0.52354	0.00022	0.00324	0.52701	**2.78%**
2002	0.46256	0.00020	0.00277	0.46554	0.04487	0.00002	0.00027	0.04516	0.50418	0.00022	0.00302	0.50742	**2.24%**
2003	0.47767	0.00021	0.00296	0.48084	0.03621	0.00002	0.00023	0.03646	0.52187	0.00023	0.00323	0.52533	**0.57%**
2004	0.47831	0.00021	0.00288	0.48140	0.03831	0.00002	0.00025	0.03857	0.52395	0.00023	0.00315	0.52733	**1.97%**
2005	0.47196	0.00022	0.00297	0.47515	0.03884	0.00002	0.00024	0.03910	0.50883	0.00024	0.00320	0.51226	**2.16%**
2006	0.50098	0.00023	0.00328	0.50448	0.03883	0.00002	0.00023	0.03908	0.53993	0.00025	0.00353	0.54371	**1.97%**
2007	0.49625	0.00024	0.00307	0.49956	0.03838	0.00002	0.00022	0.03863	0.53555	0.00026	0.00331	0.53911	**1.37%**
2008	0.49433	0.00026	0.00294	0.49752	0.03611	0.00002	0.00021	0.03634	0.53414	0.00028	0.00317	0.53759	**2.91%**

Data Year	Emission Factor, kgCO2e / kWh												% Net Electricity Imports
	For electricity GENERATED (supplied to the grid)				Due to grid transmission /distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	TOTAL
2009	0.45211	0.00027	0.00263	0.45501	0.03783	0.00002	0.00024	0.03809	0.49074	0.00030	0.00285	0.49389	**0.80%**
2010	0.45980	0.00028	0.00269	0.46277	0.05061	0.00001	0.00042	0.05104	0.49613	0.00030	0.00290	0.49933	**0.73%**
2011	0.44877	0.00029	0.00285	0.45192	0.04318	0.00001	0.00033	0.04352	0.48715	0.00032	0.00310	0.49056	**1.76%**
2012	0.50520	0.00034	0.00381	0.50935	0.04418	0.00003	0.00033	0.04454	0.54938	0.00037	0.00414	0.55389	**3.40%**
2013	0.47532	0.00036	0.00347	0.47915	0.03925	0.00003	0.00029	0.03956	0.51457	0.00039	0.00375	0.51871	**4.10%**
2014	0.42417	0.00040	0.00217	0.42673	0.03837	0.00004	0.00020	0.03860	0.46254	0.00044	0.00236	0.46534	**6.44%**
2015	0.35766	0.00064	0.00214	0.36044	0.03343	0.00006	0.00020	0.03369	0.39108	0.00070	0.00234	0.39412	**6.59%**
2016	0.28266	0.00066	0.00154	0.28486	0.02409	0.00006	0.00013	0.02428	0.30675	0.00072	0.00167	0.30913	**5.57%**
2017	0.25294	0.00065	0.00137	0.25496	0.02148	0.00005	0.00012	0.02165	0.27442	0.00070	0.00149	0.27660	**4.78%**
2018	0.23536	0.00073	0.00141	0.23750	0.02024	0.00006	0.00012	0.02042	0.25559	0.00079	0.00153	0.25792	**6.20%**
2019	0.21434	0.00081	0.00139	0.21654	0.01897	0.00007	0.00012	0.01917	0.23331	0.00088	0.00152	0.23571	**6.98%**
2020**	0.19516	0.00081	0.00139	0.19736	0.01786	0.00007	0.00012	0.01805	0.21302	0.00088	0.00152	0.21541	**6.22%**
2021**	0.21461	0.00091	0.00124	0.21676	0.01856	0.00008	0.00011	0.01875	0.23317	0.00099	0.00135	0.23551	**8.36%**
2022**	0.20493	0.00091	0.00124	0.20708	0.01811	0.00008	0.00011	0.01830	0.22304	0.00099	0.00135	0.22538	**0.00%**
2023**	0.18667	0.00091	0.00124	0.18882	0.01958	0.00008	0.00011	0.01977	0.20625	0.00099	0.00135	0.20859	**8.65%**

Notes: * From 1990-2013 the emission factor used was for French electricity only and is as published in previous methodology papers. The methodology was updated from 2014 onwards with new data on the contribution of electricity from the other interconnects, hence these figures are based on a weighted average emission factor of the conversion factors for France, the Netherlands and Ireland, based on the % share supplied.

Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) / (1 - %Electricity Total Grid LOSSES)

Emission Factor (Electricity LOSSES) = Emission Factor (Electricity CONSUMED) - Emission Factor (Electricity GENERATED)

⇒ Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) + Emission Factor (Electricity LOSSES),

** In 2020, CH_4 and N_2O emission factors were kept constant from 2019 values due to descoping (see Chapter 1 section "Conversion factors update frequency"). From 2021, CH_4 and N_2O emission factors were kept constant from 2019 values but aligned with AR5 GWPs.

Table 9: Base electricity generation emissions factors (including imported electricity)

Data Year	Emission Factor, $kgCO_2e$ / kWh												% Net Elec Imports
	For electricity GENERATED (supplied to the grid, plus imports)				Due to grid transmission/distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	Total
1990	0.6812	0.00019	0.00558	0.68697	0.05985	0.00002	0.00049	0.06036	0.74106	0.0002	0.00607	0.74733	**3.85%**
1991	0.65616	0.00017	0.0054	0.66174	0.05915	0.00002	0.00049	0.05966	0.71532	0.00019	0.00589	0.72139	**5.18%**
1992	0.62005	0.00017	0.0051	0.62532	0.05061	0.00001	0.00042	0.05104	0.67066	0.00018	0.00552	0.67636	**5.29%**
1993	0.55913	0.00017	0.00428	0.56358	0.04318	0.00001	0.00033	0.04352	0.60232	0.00018	0.00461	0.6071	**5.25%**
1994	0.53633	0.00018	0.00401	0.54051	0.05678	0.00002	0.00042	0.05722	0.59311	0.0002	0.00443	0.59773	**5.22%**
1995	0.5113	0.00018	0.00373	0.51521	0.05101	0.00002	0.00037	0.0514	0.56231	0.0002	0.0041	0.56661	**4.97%**
1996	0.48731	0.00017	0.00331	0.4908	0.04471	0.00002	0.0003	0.04502	0.53202	0.00019	0.00361	0.53582	**4.80%**
1997	0.45112	0.00017	0.00285	0.45414	0.03813	0.00001	0.00024	0.03839	0.48925	0.00019	0.00309	0.49253	**4.76%**
1998	0.45633	0.00018	0.00288	0.45939	0.04182	0.00002	0.00026	0.0421	0.49816	0.0002	0.00314	0.5015	**3.51%**
1999	0.42438	0.00018	0.00245	0.427	0.03816	0.00002	0.00022	0.0384	0.46254	0.0002	0.00267	0.46541	**3.94%**
2000	0.44628	0.00019	0.00267	0.44914	0.04084	0.00002	0.00024	0.04111	0.48712	0.00021	0.00292	0.49024	**3.82%**
2001	0.46725	0.0002	0.00289	0.47034	0.04375	0.00002	0.00027	0.04404	0.511	0.00022	0.00316	0.51438	**2.78%**
2002	0.45378	0.0002	0.00272	0.4567	0.04083	0.00002	0.00024	0.04109	0.49461	0.00022	0.00296	0.49779	**2.24%**
2003	0.47537	0.00021	0.00294	0.47853	0.04398	0.00002	0.00027	0.04427	0.51936	0.00023	0.00322	0.5228	**0.57%**
2004	0.47033	0.00021	0.00283	0.47337	0.04487	0.00002	0.00027	0.04516	0.51521	0.00022	0.0031	0.51853	**1.97%**
2005	0.46359	0.00022	0.00291	0.46673	0.03621	0.00002	0.00023	0.03646	0.49981	0.00023	0.00314	0.50318	**2.16%**

Data Year	Emission Factor, kgCO2e / kWh												% Net Elec Imports
	For electricity GENERATED (supplied to the grid, plus imports)				Due to grid transmission/distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	Total
2006	0.49263	0.00022	0.00322	0.49608	0.03831	0.00002	0.00025	0.03857	0.53094	0.00024	0.00347	0.53465	**1.97%**
2007	0.49054	0.00024	0.00303	0.49381	0.03884	0.00002	0.00024	0.0391	0.52939	0.00025	0.00327	0.53291	**1.37%**
2008	0.48219	0.00026	0.00286	0.48531	0.03883	0.00002	0.00023	0.03908	0.52102	0.00028	0.00309	0.52439	**2.91%**
2009	0.44917	0.00027	0.00261	0.45205	0.03838	0.00002	0.00022	0.03863	0.48755	0.00029	0.00284	0.49068	**0.80%**
2010	0.45706	0.00028	0.00267	0.46002	0.03611	0.00002	0.00021	0.03634	0.49317	0.0003	0.00289	0.49636	**0.73%**
2011	0.44238	0.00029	0.00281	0.44548	0.03783	0.00002	0.00024	0.03809	0.4802	0.00031	0.00305	0.48357	**1.76%**
2012	0.49023	0.00033	0.00369	0.49426	0.04287	0.00003	0.00032	0.04322	0.5331	0.00036	0.00402	0.53748	**3.40%**
2013	0.4585	0.00035	0.00334	0.46219	0.03786	0.00003	0.00028	0.03816	0.49636	0.00038	0.00362	0.50035	**4.10%**
2014	0.40957	0.00039	0.00209	0.41205	0.03705	0.00003	0.00019	0.03727	0.44662	0.00042	0.00228	0.44932	**6.44%**
2015	0.34885	0.00062	0.00209	0.35156	0.03261	0.00006	0.0002	0.03287	0.38146	0.00068	0.00229	0.38443	**6.59%**
2016	0.28088	0.00066	0.00153	0.28307	0.02394	0.00006	0.00013	0.02413	0.30482	0.00072	0.00166	0.3072	**5.57%**
2017	0.25358	0.00065	0.00137	0.2556	0.02153	0.00005	0.00012	0.0217	0.27511	0.0007	0.00149	0.2773	**4.78%**
2018	0.23104	0.00072	0.00138	0.23314	0.01987	0.00006	0.00012	0.02005	0.25091	0.00078	0.0015	0.25319	**6.20%**
2019	0.21016	0.00080	0.00137	0.21233	0.01860	0.00007	0.00012	0.01879	0.22876	0.00087	0.00149	0.23112	**6.98%**
2020**	0.19121	0.00080	0.00137	0.19338	0.01750	0.00007	0.00012	0.017690	0.20871	0.00087	0.00149	0.21107	**6.22%**
2021**	0.20496	0.00090	0.00122	0.20707	0.01773	0.00008	0.00011	0.01792	0.22269	0.00098	0.00133	0.22500	**8.36%**
2022**	0.20493	0.00090	0.00122	0.20705	0.01811	0.00008	0.00011	0.01830	0.22304	0.00097	0.00133	0.22535	**0.00%**
2023**	0.17489	0.00090	0.00122	0.17700	0.01834	0.00008	0.00011	0.01853	0.19323	0.00097	0.00133	0.19553	**8.65%**

Notes: * From 1990-2013 the emission factor used was for French electricity only. The methodology was updated from 2014 onwards with new data on the contribution of electricity from the other interconnects, hence these figures are based on a weighted average emission factor of the conversion factors for France, the Netherlands, Ireland, Belgium, and Norway, based on the % share supplied.

Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) / (1 - %Electricity Total Grid LOSSES)

Emission Factor (Electricity LOSSES) = Emission Factor (Electricity CONSUMED) – Emission Factor (Electricity GENERATED)

⇒ Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) + Emission Factor (Electricity LOSSES)

** In 2020, CH_4 and N_2O emission factors were kept constant from 2019 values due to descoping (see Chapter 1 section "Conversion factors update frequency"). From 2021, CH_4 and N_2O emission factors were kept constant from 2019 values but aligned with AR5 GWPs.

Emissions associated with Transmission & Distribution (T&D) losses from UK Grid Electricity

3.13. Transmission and distribution (T&D) factors are used to report the Scope 3 emissions associated with grid losses, i.e. the energy loss that occurs in getting the electricity from the power plant to the organisations that purchase it. The conversion factor is calculated by subtracting the emission factor for electricity generated from the emission factor for electricity consumed (see notes on Table 8, also shown above). The T&D factor therefore varies based on both the percent (%) losses and the emissions intensity of the UK grid. In the 2025 update, UK grid electricity emissions have decreased by c. 15%, but this is outweighed by an increase in T&D losses, resulting in a small net increase in the T&D factor.

Indirect/WTT Emissions from UK Grid Electricity

3.14. In addition to the GHG emissions resulting directly from the generation of electricity, there are also indirect/WTT emissions resulting from the production, transport and distribution of the fuels used in electricity generation (i.e. indirect/WTT/-fuel lifecycle emissions as included in the Fuels WTT tables). The average fuel lifecycle emissions per unit of electricity generated will be a result of the mix of different sources of fuel/primary energy used in electricity generation.

3.15. The WTT conversion factor for electricity has been calculated using the corresponding fuels WTT conversion factors and data on the total fuel consumption by type of generation from Table 5.6 and Table 6.6, DUKES 2021.

3.16. As the WTT factor for UK Grid Electricity is no longer annually updated as part of the conversion factors, the data for these calculations are no longer presented here.

Conversion factors for the Supply of Purchased Heat or Steam

3.17. Heat and Steam conversion factors have been updated in the 2025 conversion factors.

3.18. The conversion factors for the supply of purchased heat or steam represent the average emissions from the heat and steam supplied by the UK Combined Heat and Power Quality Assurance (CHPQA) scheme operators for a given year. This factor changes from year to year, as the fuel mix consumed changes and is therefore updated annually. No statistics are available that would allow the calculation of UK national average conversion factors for the supply of heat and steam from non-CHP (Combined Heat and Power) operations.

3.19. CHP simultaneously produces both heat and electricity, and there are several conventions used to allocate emissions between these products. At the extremes, emissions could be allocated wholly to heat or wholly to electricity, or in various proportions in-between.

3.20. To determine the amount of fuel attributed to CHP heat (qualifying heat output, or ‘QHO’), it is necessary to apportion the total fuel to the CHP scheme to the separate heat and electricity outputs. This then enables the fuel, and therefore emissions, associated with the QHO to be determined. There are three possible methodologies for apportioning fuel to heat and power:

a) **Method 1:** 1/3 : 2/3 Method (DUKES)
b) **Method 2**: Boiler Displacement Method
c) **Method 3**: Power Station Displacement Method

3.21. The GHG Conversion factors use the 1/3 : 2/3 DUKES method (Method 1) to determine emissions from heat and therefore only this method is described below.

Summary of Method 1: 1/3: 2/3 Method (DUKES)

3.22. Under the UK's Climate Change Agreements (CCAs)[12] (Environment Agency, 2020), this method, which is used to apportion fuel use to heat and power, assumes that twice as many units of fuel are required to generate each unit of electricity than are required to generate each unit of heat. This follows from the observation that the efficiency of the generation of electricity (at electricity only generating plant) varies from as little as 25% to 50%, while the efficiency of the generation of heat in fired boilers ranges from 50% to about 90%.

3.23. Mathematically, Method 1 can be represented as follows:

$$Heat\_Energy = \left(\frac{Total\ Fuel\ Input}{(2 \times Electricity\_Output) + Heat\_Output} \right) \times Heat\_Output$$

$$Electricity\_Energy = \left(\frac{2 \times Total\ Fuel\ Input}{(2 \times Electricity\_Output) + Heat\_Output} \right) \times Electricity\_Output$$

Where:

- 'Total Fuel Input (TFI)' is the total fuel to the prime mover.
- 'Heat Output' is the useful heat generated by the prime mover.
- 'Electricity Output' is the electricity (or the electrical equivalent of mechanical power) generated by the prime mover.
- 'Heat Energy' is the fuel to the prime mover apportioned to the heat generated.
- 'Electricity Energy' is the fuel to the prime mover apportioned to the electricity generated.

3.24. This method is used only in the UK for accounting for primary energy inputs to CHP where the CHP generated heat and electricity is used within a facility with a CCA.

Calculation of CO_2 Emissions Factor for CHP Fuel Input, FuelMixCO_2factor

3.25. The value FuelMixCO_2factor referred to above is the carbon emission factor per unit fuel input to a CHP scheme. This factor is determined using fuel input data provided by CHP scheme operators to the CHPQA programme, which is held in confidence.

The value for FuelMixCO_2factor is determined using the following expression:

$$\text{FuelMixCO2factor} = \frac{\sum(\text{Fuel Input} \times \text{Fuel CO2 Emissions Factor})}{\text{TFI}}$$

Where:

[12] Climate Change Agreements (CCAs) are agreements between UK energy intensive industries and UK Government, whereby industry undertakes to make challenging, but achievable, improvements in energy efficiency in exchange for a reduction in the Climate Change Levy (CCL).

- FuelMixCO_2factor is the composite emissions factor (in tCO_2/MWh thermal fuel input) for a scheme
- Fuel Input is the fuel input (in MWh thermal, MWh_{th}) for a single fuel supplied to the prime mover
- Fuel CO_2 Emissions factor is the CO_2 emissions factor (in tCO_2/MWh_{th}) for the fuel considered.
- TFI is total fuel input (in MWh thermal) for all fuels supplied to the prime mover.

3.26. Fuel inputs and emissions factors are evaluated on a Gross Calorific Value (Higher Heating Value) basis. The following Table 10 provides the individual fuel types considered under the CHPQA scheme and their associated emissions factors, consistent with other reporting; fuel mix varies every year and thus there are zero entries for specific fuel types.

Table 10: Fuel types and associated emissions factors used in the determination of FuelMixCO_2factor

Fuel	CO_2 Emissions Factor ($kgCO_2/kWh_{th}$)
Biodiesel, bioethanol etc	-
Biomass (such as woodchips, chicken litter etc)	-
Blast furnace gas	0.93
Butane	0.21
Coal and lignite	0.32
Coke oven gas	0.14
Coke, and semi-coke	0.34
Domestic refuse (raw)	0.16
Ethane	0.18
Fuel oil	0.27
Gas oil	0.25
Hydrogen	-
Landfill gas	-
Methane	0.18
Mixed refinery gases	0.25
Natural gas	0.18
Other	0.18
Other Biogas (e.g. gasified woodchips)	-
Other gaseous waste	0.18
Other liquid waste (non-renewable)	0.25
Other liquid waste (renewable)	-
Other oils	0.25
Other solid waste	0.16
Petroleum coke	0.34

Fuel	CO_2 Emissions Factor ($kgCO_2/kWh_{th}$)
Petroleum gas	0.21
Propane	0.21
Refuse-derived Fuels (RDF)	0.16
Sewage gas	-
Unknown process gas	0.18
Uranium	-
VOC's	-
Waste exhaust heat from high temperature processes	-
Waste heat from exothermic chemical reactions	-
Other waste heat	-
Wood Fuels (woodchips, logs, wood pellets etc)	-
Fuel cells	0.18
Syngas / Other Biogas (e.g. gasified woodchips)	-
Pentane	-
Other Industrial By-Product gases	0.18
Hospital waste	0.16
Hydrogen (as a by-product)	-
Hydrogen (as a primary fuel)	-
Oil shale	0.27
Bituminous or asphaltic substance	0.27
Carbon Monoxide	0.18
Agricultural residues	-
Arboricultural & Forestry residues	-
Biogas produced by an AD plant	-
Branches and prunings	-
Building and demolition materials	-
Distillers grain	-
Dried wood chips	-
Fatty Acid Methyl Esters (biodiesel)	-
Gases otherwise produced from AD of biological materials	-
Industrial waste	0.16
Milling residues	-
Municipal solid waste	0.16
Organic waste material such as manure, chicken litter, food waste	-
Other commercial renewable oils	-
Other Waste Woods	-

Fuel	CO_2 Emissions Factor ($kgCO_2/kWh_{th}$)
Other wood fuels	-
Paper sludge	-
Rapeseed oil	-
Refinery asphaltic oil	0.27
Refuse derived fuel	0.16
Roundwood	-
Spent solvents	0.25
Straw	-
Syngas from Wood Chips	-
Tallow	-
Undried woodchips	-
Used cooking oil	-
Visibly Clean Waste Wood (grade A of PAS 111)	-
Wood pellets	-

Sources: GHG Conversion factors for Company Reporting (2025 update) and UK GHGI (Ricardo, 2025).

Note: For waste derived fuels, the emission factor can vary significantly according to the waste mix. Therefore, if you have site-specific data, it is recommended that you use that instead of the waste derived fuel emissions factors in this table.

3.27. The 1/3 : 2/3 method (Method 1) was used to calculate the new heat/steam conversion factors provided in the Heat and Steam tables of the 2025 GHG Conversion factors. This is shown in Table 11. It is important to note that the conversion factors update year is two years ahead of the data year. For example, the most recent emission factor for the 2025 GHG Conversion factors is based on the data year of 2023 in the Table 11.

3.28. While not used in the 2025 GHG conversion factors, the factor for heat from CHP and power from CHP has also been calculated using the other two CHP methods and the DUKES power method. These are: 0.22898 CO_2/kWh heat (Boiler displacement), 0.21250 CO_2/kWh heat (Power station displacement), 0.33239 CO_2/kWh power (DUKES method), 0.34274 CO_2/kWh power (Boiler displacement), 0.37090 CO_2/kWh power (power station displacement).

Table 11: Heat/Steam CO_2 emission factor for DUKES 1/3 2/3 method.

Data Year	$kgCO_2$/kWh supplied heat/steam
	Method 1 (DUKES: 2/3rd - 1/3rd)
2001	0.23770
2002	0.22970
2003	0.23393
2004	0.22750

Data Year	$kgCO_2/kWh$ supplied heat/steam
	Method 1 (DUKES: 2/3rd - 1/3rd)
2005	0.22105
2006	0.23072
2007	0.23118
2008	0.22441
2009	0.22196
2010	0.21859
2011	0.21518
2012	0.20539
2013	0.20763
2014	0.20245
2015	0.19564
2016	0.18618
2017	0.17447
2018	0.17102
2019	0.17150
2020	0.17574
2021	0.17791
2022	0.17619
2023	0.17355

Calculation of Non-CO_2 and Indirect/WTT Emissions Factor for Heat and Steam

3.29. CH_4 and N_2O emissions have been estimated relative to the CO_2 emissions, based upon activity weighted average values for each CHP fuel used (using relevant average fuel conversion factors from the UK GHGI). Where fuels are not included in the UK GHGI, the value for the most similar alternative fuel was used.

3.30. Indirect/WTT GHG conversion factors have been estimated relative to the CO_2 emissions, based upon activity weighted average indirect/WTT GHG emission factor values for each CHP fuel used (see “Indirect/WTT Emissions from Fuels” section for more information). Where fuels are not included in the set of indirect/WTT GHG conversion factors provided in the 2025 GHG Conversion factors, the value for the most similar alternative fuel was used.

3.31. The final conversion factors for supplied heat or steam utilised are presented in the ‘Heat and Steam’ tables of the 2025 GHG Conversion factors and are counted as Scope 2 emissions under the GHG Protocol.

3.32. For district heating systems, the location of use of the heat will often be some distance from the point of production and therefore there are distribution energy losses. These losses are typically around 5% (provided by Ricardo's CHP team in a personal communication), which need to be factored into the calculation of overall GHG emissions where relevant and are counted as Scope 3 emissions under the GHG Protocol (similar to the treatment of transmission and distribution losses for electricity).

4. Refrigerant and Process Emission Factors

Section summary

4.1. Refrigerant and process conversion factors should be used for reporting leakage from air-conditioning and refrigeration units or the release to the atmosphere of other substances that have a global warming potential.

4.2. This section of the methodology paper relates to the "Refrigerant & other" worksheet available in both the full and condensed set of the 2025 UK GHG Conversion factors set.

4.3. Refrigerant and process conversion factors have been held constant from the 2023 release (almost all values have been updated to use AR5 GWPs (and where AR5 values were not available, but AR6 values were, AR6 GWPs have been used))

Summary of changes since the previous update

4.4. There were no major methodological changes in the 2025 update. Refrigerant and process conversion factors remain constant since the publication of 2023 GHG Conversion factors.

Global Warming Potentials of Greenhouse Gases

4.5. The GWP values have been updated to those published by the IPCC in the Fifth Assessment Report (IPCC, 2014). There are a small number of refrigerants that are not included in the Fifth Assessment Report. In these cases, we have adopted values from either IPCC Sixth Assessment Report (IPCC, 2023), the IPCC Fourth Assessment Report (IPCC, 2007), or Annex IV of the EU F-gas regulation (517/2014)[11].

Greenhouse Gases Listed in the Kyoto Protocol

4.6. Mixed/Blended gases: GWP values for refrigerant blends are calculated on the basis of the percentage blend composition (e.g. the GWP for R404A that comprises of 44% HFC125[13], 52% HFC143a and 4% HFC134a is [3170 x 0.44] + [4800 x 0.52] + [1300x 0.04] = 3943). A limited selection of common blends is presented in the Refrigerant tables. This calculation is done separately for Kyoto components and non-Kyoto components, so that users of blends which include both can distinguish what proportion of the GWP relates specifically to Kyoto components while also presenting the total GWP.

[13] HFC: Hydrofluorocarbon

Other Greenhouse Gases

4.7. CFCs and HCFCs[14]: While these products typically have high GWPs, they were excluded from Kyoto Protocol reporting due to already being controlled under the Montreal Protocol due to them being Ozone Depleting Substances (ODS). Most use of ODS are now banned in the UK, so these are unlikely to be relevant to UK users unless they have a legacy system and/or are using the product for specific exempted end-uses.

4.8. Other substances which are neither controlled under the Kyoto Protocol or Montreal protocol. Many non-ODS substances which have comparatively low GWPs (typically <10) or are not widely used are not included under the Kyoto Protocol or Montreal protocol but are included in domestic F-gas regulations. These are included here for completeness, and it also means that the GWP values for blends should closely align with the calculations required for labelling F-gas equipment.

[14] CFCs: Chlorofluorocarbons; HCFCs: Hydrochlorofluorocarbons

5. Passenger Land Transport Emission Factors

Section summary

5.1. Conversion factors for passenger land transport are included in this section of the methodology paper. This section includes vehicles owned by the reporting organisation (Scope 1), business travel in other vehicles (e.g. employee own car for business use, hire car, public transport (Scope 3)), and electric vehicles (EVs) (Scope 2). Other Scope 3 conversion factors included here are for transmission and distribution losses for electricity used for electric vehicles, WTT for passenger transport (vehicles owned by reporting organisation) and other business travel.

5.2. Motorcycles, methane and nitrous oxide conversion factors remain constant since the 2021 GHG Conversion factors but have been updated from AR4 to AR5 GWP values. WTT conversion factors also remain constant and have been updated from AR4 to AR5 GWP values.

5.3. Note that passenger land transport factors should only be used in the absence of data for fuel or electricity consumption for the vehicles in question.

5.4. Table 12 shows where the related worksheets to the passenger land transport conversion factors are available in the online spreadsheets of the UK GHG Conversion factors.

Table 12: Related worksheets to passenger land transport emission factors

Worksheet name	Full set	Condensed set
Passenger vehicles	Y	Y
UK Electricity for Electric Vehicles (EVs)	Y	Y
UK Electricity T&D for EVs	Y	Y
Business travel – land*	Y	Y
WTT – pass vehicles & travel – land*	Y	N

* cars and motorbikes only

Summary of changes since the previous update

5.5. In 2020 and 2021, transport trends had been affected by measures introduced to prevent and reduce the global spread of coronavirus (COVID-19). DfT's statistics shows that passenger kilometres and thus occupancy levels for certain modes of transport (buses, cars, vans, rail, air) have significantly dropped in 2020 and they didn't go back to pre-COVID levels in 2021 too. For buses factors, it was decided that pre-COVID occupancy levels would be retained for the years 2020 and 2021 in the 2022 and 2023 updates. In the 2025 update of GHG Conversion Factors, 2023/24 occupancy level statistics from DfT were used. Please see the two illustrative tables below for buses:

Table 13: DfT's Table BUS03a_km - Passenger kilometres on local bus services by metropolitan area status and country: Great Britain

Year	Great Britain
2016/17	27.28
2017/18	26.98
2018/19	26.98
2019/20	25.88 - *retained value for the 2022 and 2023 updates*
2020/21	9.91
2021/22	18.25
2022/23	22.16

Table 14: DfT's Table BUS03b - Average bus occupancy on local bus services by metropolitan area status and country: Great Britain

Year	Great Britain
2016/17	11.3
2017/18	11.6
2018/19	11.8
2019/20	11.5 - *retained value for the 2022 and 2023 updates*
2020/21	5.3
2021/22	8.8
2022/23	11.1
2023/24	11.0

Direct Emissions from Passenger Cars

Conversion factors for Petrol and Diesel Passenger Cars by Engine Size

5.6. The methodology for calculating average conversion factors for passenger cars is based upon a combination of datasets on the average new vehicle regulatory emissions for vehicles registered in the UK, and an uplift to account for differences between these and real-world driving performance emissions.

5.7. The regulatory test cycle/procedure transitioned from the previous NEDC to the new WLTP[15], which is intended to bring the results of tests under regulatory testing conditions closer to those observed in the real-world. Light duty vehicles (cars and vans) registered in the EU from 2020 have WLTP-based regulatory CO_2 emissions values and these are used in the calculation of conversion factors where possible. However, the majority of vehicles in the UK fleet are registered before 2020 and so continue to use NEDC-based values.

5.8. SMMT[16] provides numbers of registrations and average gCO_2/km figures for new vehicles registered from 1999 to 2024[17]. The dataset represents a good indication of the relative gCO_2/km by size and market segment category. Table 15 presents the average NEDC CO_2 conversion factors used for vehicles registered between 2005-2019 and the average WLTP CO_2 conversion factors used for vehicles registered from 2020.

[15] NEDC = New European Driving Cycle, which has been the standard cycle used in the type approval of all new passenger cars and vans historically. From 2017 there has been a phased transition in vehicle testing using the new WLTP (Worldwide Harmonised Light Vehicle Test Procedure); from September 2018 onwards all new cars and vans must have been tested/reported values under WLTP. More information is available on the VCA website: https://www.vehicle-certification-agency.gov.uk/fcb/wltp.asp

[16] SMMT is the Society of Motor Manufacturers and Traders that represents the UK auto industry. http://www.smmt.co.uk/

[17] The SMMT gCO_2/km dataset for 1997 represented around 70% of total registrations, which rose to about 99% by 2000 and essentially all vehicles thereafter.

Table 15: Average CO_2 conversion factors and total registrations by engine size for 2008 to 2024 (based on data sourced from SMMT)

Vehicle Type	Engine size	Size label	NEDC* gCO_2 per km	WLTP gCO_2 per km	Total no. of registrations	% Total
Petrol car	< 1.4 l	Small	117.4	129.3	12,315,592	63%
	1.4 - 2.0 l	Medium	148.8	153.9	6,484,800	33%
	> 2.0 l	Large	219.2	246.4	723,035	4%
Average petrol car		**All**	***130.4***	***143.7***	***19,523,427***	***100%***
Diesel car	<1.7 l	Small	109.5	136.5	5,028,713	39%
	1.7 - 2.0 l	Medium	132.1	158.3	5,438,144	42%
	> 2.0 l	Large	161.7	210.4	2,586,682	20%
Average diesel car		**All**	***128.7***	***165.2***	**13,053,539**	**100%**

* For 2019 and 2018, NEDCe reported data is converted to NEDC, based on an estimated 9% correlation factor from SMMT based on analysis of vehicle models where both NEDC and NEDCe values exist. NEDCe (NEDC equivalent) data are officially reported figures calculated from WLTP using an official regulatory correlation tool. They are used to check compliance of new vehicle registrations with the EU-wide regulatory CO_2 targets set on NEDC basis.

5.9. The SMMT data is used in conjunction with DfT's ANPR (Automatic Number Plate Recognition) data to weight the conversion factors to account for the age and activity distribution of the vehicles on the UK's roads.

5.10. The ANPR data has been collected annually (since 2007) over 256 sites in the UK on different road types (urban and rural major/minor roads, and motorways) and regions. Measurements are made at each site on one weekday (8 am-2 pm and 3 pm-9 pm) and one-half weekend day (either 8 am-2 pm or 3 pm-9 pm) each year in June and are currently available for 2007 - 2011, 2013 - 2015, 2017, 2019 and 2021. There are approximately 1.4 -1.7 million observations recorded from all the sites each year, and they cover various vehicle and road characteristics such as fuel type, age of the vehicle, engine sizes, vehicle weight and road types.

5.11. Counts of vehicles were extracted from the 2021 ANPR dataset and categorised according to their engine size, fuel type and year of registration. The CO_2 conversion factors for petrol and diesel passenger cars were subsequently calculated based upon the equation below:

$$gCO_2/km = \sum \left(gCO_2/km_{yr\ reg} \times \frac{ANPR_{yr\ reg}}{ANPR_{total\ 2019}} \right)$$

5.12. A limitation of the NEDC is that it takes no account of further 'real-world' effects that can have a significant impact on fuel consumption. These include use of accessories (air conditioning, lights, heaters etc.), vehicle payload (only driver +25kg is considered in tests, no passengers or further luggage), poor maintenance (tyre under inflation, maladjusted tracking, etc.), gradients (tests effectively assume a level road), weather, more aggressive driving style, etc. It is therefore desirable to uplift NEDC based data to bring it closer to anticipated 'real-world' vehicle performance.

5.13. An uplift factor over NEDC based gCO_2/km factors is applied to account for the combined 'real-world' effects on fuel consumption. The uplift applied varies over time and is based on work performed by (ICCT, 2017); this study used data on almost 1.1 million vehicles from fourteen data sources and eight countries, covering the fuel consumption/CO_2 from actual real-world use and the corresponding type-approval values. The values used are based on average data from the two UK-based sources analysed in the ICCT study, as summarised in Table 16 below and illustrated in Figure 2 alongside the source data/chart reproduced from the ICCT (2017) report.

5.14. WLTP based gCO_2/km factors are used from 2020 onwards and require a different uplift to account for the real-world effects described above. The uplifts used were based on a report published in 2024 from the European Commission[18], and the average values are shown in Table 16. The uplift is noticeably lower due to WLTP based factors being closer to real-world driving than NEDC based factors.

Table 16: Average 'real-world' uplift for the UK applied to gCO_2/km data

Data year	2007	2008	2009	2010	2011	2012	2013	2014	2015
RW uplift (%)	15.65	18.30	20.95	23.60	26.25	27.63	29.00	33.33	41.50
Data year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
RW uplift (%)	38.00	31.50	31.50	31.50	22.25	22.48	22.75	22.95	22.99

Notes: 2007-2019 values applied to NEDC based factors. 2020-2024 values are an average of uplifts applied to WLTP based factors. Uplifts in this table are only for petrol, diesel, hybrid and unknown fuel cars, not for plug-in hybrid or battery electric cars.

5.15. The above uplifts have been applied to the ANPR weighted SMMT gCO_2/km to give the 'Real-World' 2025 GHG Conversion factors. The average car conversion factors were calculated by weighting with the relative mileage of the different categories. This calculation utilised data from the UK GHG Inventory on the relative % total mileage by petrol and diesel cars. Overall, for petrol and diesel, this split in total annual mileage was 56.7% petrol and 43.3% diesel, and can be compared to the respective total registrations of the different vehicle types for 2024, which were 59.9% petrol and 40.1% diesel.

[18] Available here: https://climate.ec.europa.eu/news-your-voice/news/first-commission-report-real-world-co2-emissions-cars-and-vans-using-data-board-fuel-consumption-2024-03-18_en#:~:text=Since%20January%202021%2C%20all%20new,and%20the%20total%20distance%20driven.

5.16. An adjustment factor is applied to account for the biofuel content of transportation fuels.

5.17. Conversion factors for CH_4 and N_2O are based on the emission factors from the UK GHGI 2019 (Ricardo Energy & Environment, 2021) and updated to align with AR5 GWP values. The emission factors used in the UK GHGI are based on COPERT 5 version 6 (EMISIA, 2022).

5.18. The final conversion factors for petrol and diesel passenger cars by engine size are presented in the ‘Passenger vehicles’ and ‘Business travel- land’ worksheets of the 2025 GHG Conversion factors set.

Figure 2: Updated GCF 'Real world' uplift values for the UK based on (ICCT, 2017)

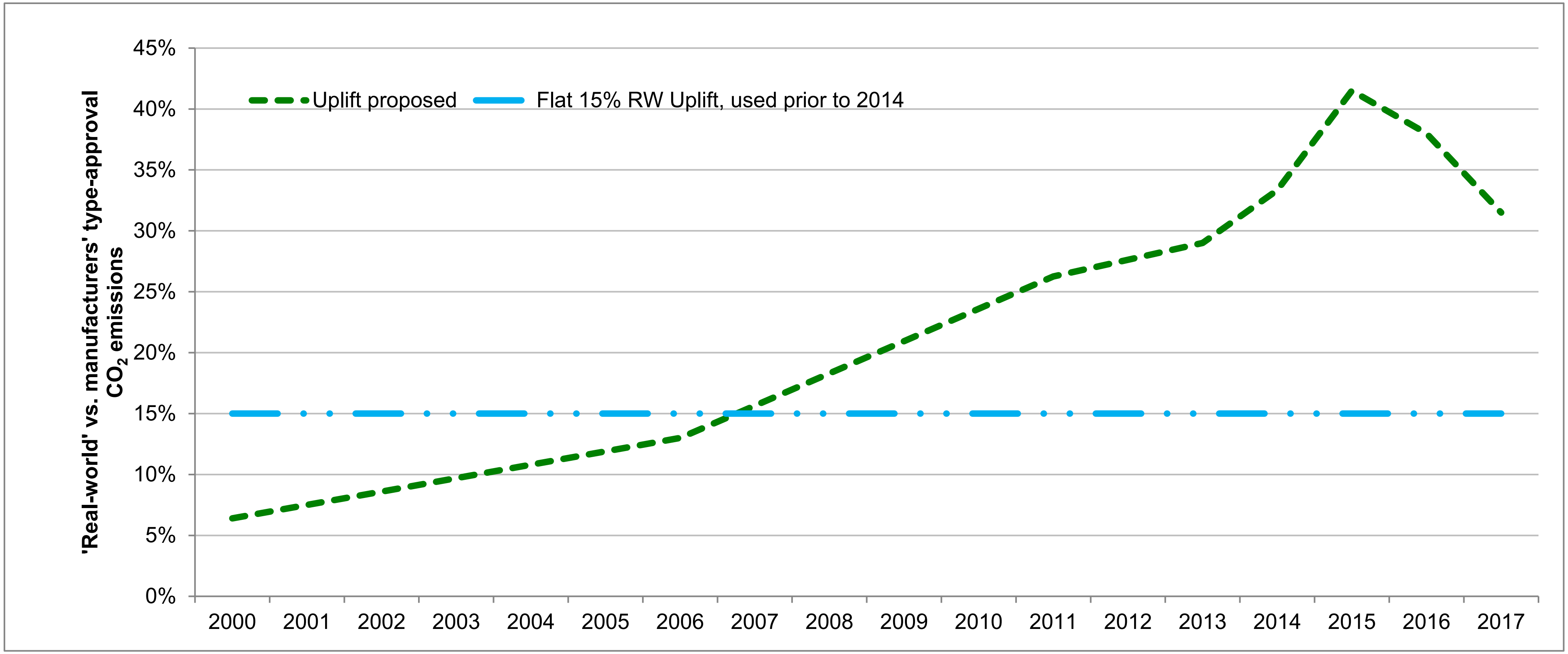
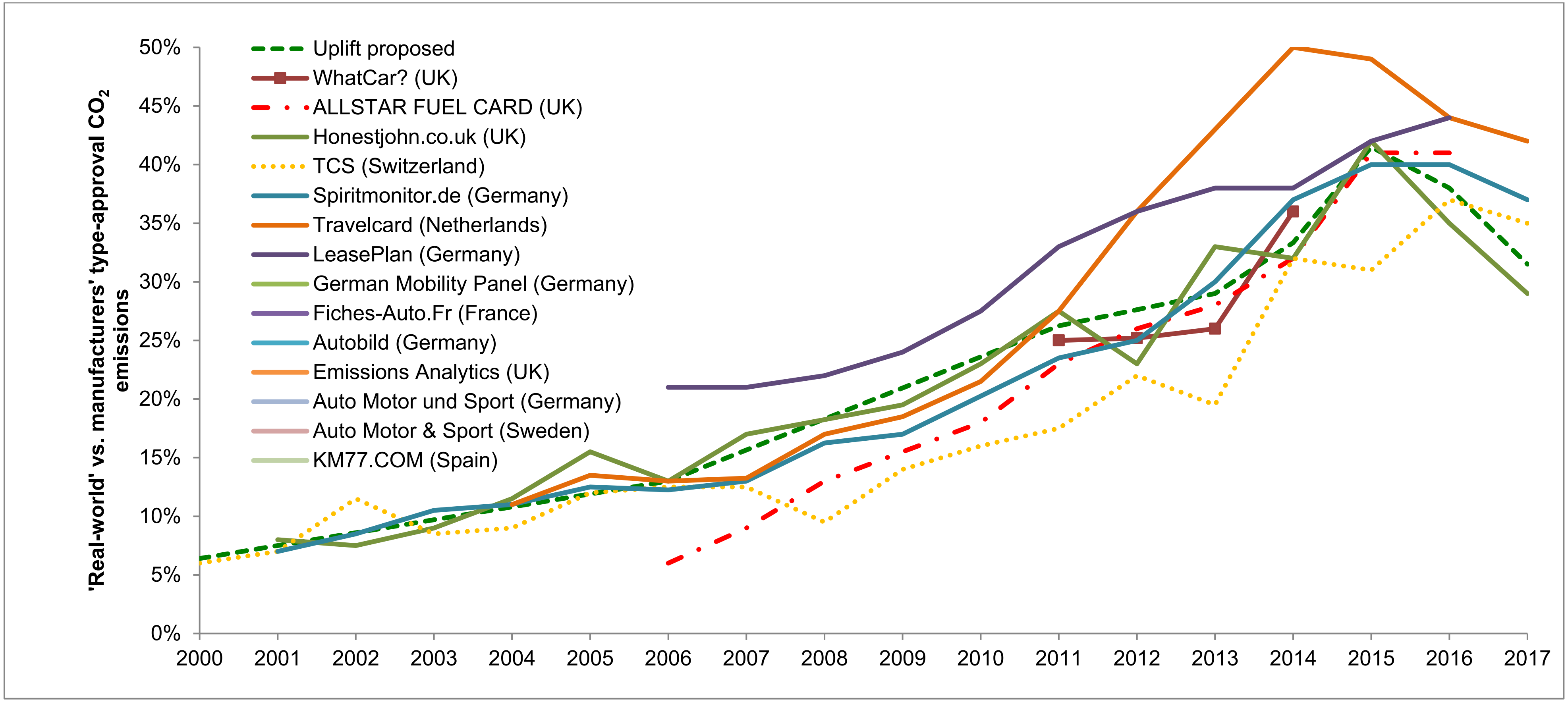


Figure 3: Comparison of 'Real world' uplift values from various sources (ICCT, 2017)



Notes: In the above charts a y-axis value of 0% would mean no difference between the CO_2 emissions per km experienced in 'real-world' driving conditions and those from official type-approval testing protocol.

Hybrid, LPG and CNG Passenger Cars

5.19. The methodology used in the 2025 update for small, medium and large hybrid petrol/diesel electric cars is the same as that used for conventional petrol and diesel vehicles. The conversion factors are based on the number of registrations and average of the gCO_2/km figures provided by SMMT for new hybrid vehicles registered between 2013 and 2024. These are weighted using DfT's ANPR (Automatic Number Plate Recognition) data and an uplift applied to account for ‘real-world’ driving.

5.20. The SMMT source dataset used in the derivation of passenger car conversion factors has information on plug-in hybrid cars, which is utilised as described below, though has not been used in the calculation of hybrid conversion factors.

5.21. Due to the significant size and weight of the LPG and CNG fuel tanks, it is assumed only medium and large sized vehicles are available. In the 2025 GHG Conversion factors, CO_2 conversion factors for CNG and LPG medium and large cars are derived by multiplying the equivalent petrol EF by the ratio of CNG (and LPG) to petrol conversion factors on a unit energy (Net CV) basis. For example, for a Medium car run on CNG:

$$\mathrm{gCO_2/km_{CNG\ Medium\ car}} = \mathrm{gCO_2/km_{Petrol\ Medium\ car}} \times \frac{\mathrm{gCO_2/kWh_{CNG}}}{\mathrm{gCO_2/kWh_{Petrol}}}$$

5.22. Conversion factors for CH_4 and N_2O are based on the emission factors from the UK GHGI 2019 (Ricardo Energy & Environment, 2021) and updated to align with AR5 GWP values. The emission factors used in the UK GHGI are based on COPERT 5 version 6 (EMISIA, 2022).

Plug-in Hybrid Electric and Battery Electric Passenger Cars (xEVs)

5.23. Since the number of electric vehicles (xEVs[19]) in the UK fleet is rapidly increasing (and will continue to increase in the future), at least for passenger cars and vans, there is a need for specific conversion factors for such vehicles to complement conversion factors for vehicles fuelled primarily by petrol, diesel, natural gas or LPG.

5.24. These conversion factors are currently presented in a number of data tables in the GHG Conversion factors workbook, according to the type / ‘Scope’ of the emission component. The following tables / worksheets, shown in Table 17, are required for BEVs (battery electric vehicles) and PHEVs (plug-in hybrid electric vehicles), and related REEVs (range-extended electric vehicles). Since there are still relatively few models available on the market, all PHEVs and REEVs are grouped into a single category. There are not yet meaningful numbers of fuel cell electric vehicles (FCEVs) in use, so these are not included at this time.

[19] xEVs is a generic term used to refer collectively to battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), range-extended electric vehicles (REEVs, or ER-EVs, or REX) and fuel cell electric vehicles (FCEVs).

5.25. Table 17 provides an overview of the GHG Conversion Factor tables that have been developed for the reporting of emissions from electric vehicles, which aligns with current reporting.

Table 17: Summary of emissions reporting and tables for electric vehicle emission factors

Emission component	Emissions Scope and Reporting Worksheet	Plug-in hybrid electric vehicles (PHEVs)	Battery electric vehicles (BEVs)
Direct emissions from the use of petrol or diesel	**Scope 1:** • Passenger vehicles • Delivery vehicles	Yes	(Zero emissions)
Emissions resulting from electricity use: (a) Electricity Generation (b) Electricity Transmission & Distribution losses	**(a) Scope 2:** • UK electricity for EVs **(b) Scope 3:** • UK electricity T&D for EVs	Yes	Yes
Upstream emissions from the use of liquid fuels and electricity	**Scope 3:** • WTT- passenger vehicles & travel- land • WTT- delivery vehicles & freight	Yes	Yes
Total GHG emissions for all components for not directly owned /controlled assets	**Scope 3:** • Business travel- land • Freighting goods • Managed assets- vehicles	Yes	Yes

Data inputs, sources and key assumptions

5.26. A number of data inputs and assumptions were needed to calculate the final GHG conversion factors for electric cars and vans. Table 20 provides a summary of the key data inputs, the key data sources and other assumptions used for the calculation of the final xEV conversion factors.

5.27. The calculation of UK fleet average conversion factors for electric vehicles from 2010 to 2020 were based on data obtained from the EEA CO_2 monitoring databases for cars and vans, which are publicly available (EEA, 2021a), (EEA, 2021b). These databases provide details by manufacturer and vehicle type (and by EU member state) on the annual number of registrations and test cycle performance for average CO_2 emissions (gCO_2/km) and electrical energy consumption (Wh/km, for plug-in vehicles). This allows for the classification of vehicles into market segments and the calculation of registrations weighted average performance figures.

5.28. Starting from 2021, the European Environment Agency (EEA) no longer provides new UK vehicle data which was previously used in calculating the factors for xEVs cars. Responsibility for the publication of the UK vehicle regulatory data has now transferred from the EEA to the UK Vehicle Certification Agency (VCA) with the data expected to be published annually. As of the time of this publication only the 2021 data (VCA, 2023) was available, therefore in the 2025 update, the number of new registrations of xEVs cars in UK in 2023 have been obtained from the UK DfT’s vehicle licensing statistics data file VEH_0270 (DfT, 2023). Vehicle model specific CO_2 emissions and energy consumption for individual models are assumed to have remained the same since the previous year and derived from the previous version of the VCA regulatory database (VCA, 2023). For new xEVs models that were not included in previous version of VCA regulatory database, their vehicle model specific CO_2 emissions and energy consumption were assumed to be the same as those values from the same vehicle models in seven other EEA countries (France, Germany, Ireland, Belgium, Netherlands, Spain, and Portugal) in the latest EEA database (EEA, 2023).

5.29. The xEV models included in the current databases (which cover registrations up to the end of 2023) and their allocation to different market segments, are presented in Table 18. To calculate the corresponding conversion factors for the tables split by car ‘size’ category, it is assumed segments A and B are ‘Small’ cars, segments C and D are ‘Medium’ cars and all other segments are ‘Large’ cars.

Table 18: xEV car models and their allocation to different market segments

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
AUDI	A3	C	Lower Medium	-	Yes
AUDI	A5	E	Executive	Yes	-
AUDI	A6	E	Executive	-	Yes
AUDI	A7	E	Executive	-	Yes
AUDI	A8	F	Luxury Saloon	-	Yes
AUDI	E-TRON	H	Dual Purpose	Yes	-
AUDI	Q3	H	Dual Purpose	-	Yes
AUDI	Q4	H	Dual Purpose	Yes	-
AUDI	Q5	H	Dual Purpose	-	Yes
AUDI	Q7	H	Dual Purpose	-	Yes
AUDI	Q8	H	Dual Purpose	-	Yes
BENTLEY	BENTAYGA	F	Luxury Saloon	-	Yes
BENTLEY	FLYING SPUR	F	Luxury Saloon	-	Yes
BMW	I3	B	Supermini	Yes	-
BMW	I3 REEV	B	Supermini	-	Yes
BMW	I4	D	Upper Medium	Yes	-

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
BMW	I5	E	Executive	Yes	-
BMW	I8	G	Specialist Sports	-	Yes
BMW	IX	H	Dual Purpose	Yes	-
BMW	IX3	H	Dual Purpose	Yes	-
BMW	SERIES 2	C	Lower Medium	-	Yes
BMW	SERIES 3	D	Upper Medium	-	Yes
BMW	SERIES 5	E	Executive	-	Yes
BMW	SERIES 7	F	Luxury Saloon	Yes	Yes
BMW	X1	H	Dual Purpose	-	Yes
BMW	X2	H	Dual Purpose	-	Yes
BMW	X3	H	Dual Purpose	-	Yes
BMW	X5	H	Dual Purpose	-	Yes
BMW	XM	F	Luxury Saloon	-	Yes
BYD	ATTO	H	Dual Purpose	Yes	-
BYD	DOLPHIN	B	Supermini	Yes	-
BYD	E6Y	C	Lower Medium	Yes	-
BYD	SEAL	D	Upper Medium	Yes	-
CHEVROLET/DAEWOO	VOLT	C	Lower Medium	-	Yes
CITROEN	BERLINGO	I	Multi Purpose Vehicle	Yes	-
CITROEN	C4	C	Lower Medium	Yes	-
CITROEN	C5	D	Upper Medium	-	Yes
CITROEN	C-ZERO	A	Mini	Yes	-
CITROEN	E-SPACETOURER	I	Multi Purpose Vehicle	Yes	-
CUPRA	BORN	C	Lower Medium	Yes	-
DS	DS3	B	Supermini	Yes	-
DS	DS4	C	Lower Medium	-	Yes
DS	DS7	H	Dual Purpose	-	Yes
DS	DS9	E	Executive	-	Yes
FERRARI	296	G	Specialist Sports	-	Yes
FERRARI	SF90	G	Specialist Sports	-	Yes
FIAT/ALFA ROMEO	500	A	Mini	Yes	-
FIAT/ALFA ROMEO	600	B	Supermini	Yes	-
FIAT/ALFA ROMEO	DUCATO	V	Van	Yes	-

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
FIAT/ALFA ROMEO	TONALE	H	Dual Purpose	-	Yes
FISKER	OCEAN	H	Dual Purpose	Yes	-
FORD	FOCUS	C	Lower Medium	Yes	-
FORD	KUGA	H	Dual Purpose	-	Yes
FORD	MUSTANG	H	Dual Purpose	Yes	-
FORD	MONDEO	D	Upper Medium	-	Yes
FORD	TOURNEO	H	Dual Purpose	-	Yes
FORD	TRANSIT	V	Van	Yes	Yes
GENESIS	G80	E	Executive	Yes	-
GENESIS	GV60	H	Dual Purpose	Yes	-
GENESIS	GV70	H	Dual Purpose	Yes	-
GREAT WALL	FUNKY CAT	C	Lower Medium	Yes	-
HONDA	CR-V	H	Dual Purpose	-	Yes
HONDA	E'	B	Supermini	Yes	-
HONDA	ENY1	C	Lower Medium	Yes	-
HYUNDAI	IONIQ	C	Lower Medium	Yes	Yes
HYUNDAI	IX 35/TUCSON	H	Dual Purpose	-	Yes
HYUNDAI	KONA	H	Dual Purpose	Yes	-
HYUNDAI	SANTA FE	H	Dual Purpose	-	Yes
JAGUAR	E-PACE	C	Lower Medium	-	Yes
JAGUAR	F-PACE	C	Lower Medium	-	Yes
JAGUAR	I-PACE	H	Dual Purpose	Yes	-
JEEP	AVENGER	C	Lower Medium	Yes	-
JEEP	COMPASS	H	Dual Purpose	-	Yes
JEEP	GRAND CHEROKEE	H	Dual Purpose	-	Yes
JEEP	RENEGADE	H	Dual Purpose	-	Yes
KIA	CEE'D	C	Lower Medium	-	Yes
KIA	EV6	C	Lower Medium	Yes	-
KIA	EV9	H	Dual Purpose	Yes	-
KIA	OPTIMA	D	Upper Medium	-	Yes
KIA	SORENTO	H	Dual Purpose	-	Yes
KIA	SOUL	C	Lower Medium	Yes	-
KIA	SPORTAGE	H	Dual Purpose	-	Yes
KIA	NIRO	H	Dual Purpose	Yes	Yes
KIA	XCEED	H	Dual Purpose	-	Yes
LAND ROVER	DEFENDER	H	Dual Purpose	-	Yes
LAND ROVER	DISCOVERY	H	Dual Purpose	-	Yes

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
LAND ROVER	RANGE ROVER	H	Dual Purpose	-	Yes
LAND ROVER	RANGE ROVER EVOQUE	H	Dual Purpose	-	Yes
LAND ROVER	RANGE ROVER SPORT	H	Dual Purpose	-	Yes
LAND ROVER	RANGE ROVER VELAR	H	Dual Purpose	-	Yes
LEVC	TX	I	Multi Purpose Vehicle	-	Yes
LEXUS	NX	H	Dual Purpose	-	Yes
LEXUS	RX	H	Dual Purpose	-	Yes
LEXUS	RZ	H	Dual Purpose	Yes	-
LEXUS	UX	H	Dual Purpose	Yes	-
LOTUS	ELETRE	H	Dual Purpose	Yes	-
MAHINDRA	E20PLUS	C	Lower Medium	Yes	-
MAXUS	MIFA	I	Multi Purpose Vehicle	Yes	-
MAZDA	CX-60	H	Dual Purpose	-	Yes
MAZDA	MX30	C	Lower Medium	Yes	Yes
MCLAREN	ARTURA	G	Specialist Sports	-	Yes
MCLAREN	P1	G	Specialist Sports	-	Yes
MCLAREN	SPEEDTAIL	G	Specialist Sports	-	Yes
MERCEDES BENZ	A CLASS	B	Supermini	Yes	-
MERCEDES BENZ	A CLASS (2019)	C	Lower Medium	-	Yes
MERCEDES BENZ	B CLASS	C	Lower Medium	Yes	Yes
MERCEDES BENZ	C CLASS	D	Upper Medium	-	Yes
MERCEDES BENZ	CLA	D	Upper Medium	-	Yes
MERCEDES BENZ	E CLASS	E	Executive	-	Yes
MERCEDES BENZ	EQA	C	Lower Medium	Yes	-
MERCEDES	EQB	H	Dual Purpose	Yes	-
MERCEDES BENZ	EQC	H	Dual Purpose	Yes	-
MERCEDES	EQE	E	Executive	Yes	-
MERCEDES BENZ	EQS	F	Luxury Saloon	Yes	-
MERCEDES BENZ	EQV	I	Multi Purpose Vehicle	Yes	-
MERCEDES BENZ	EVITO	I	Multi Purpose Vehicle	Yes	-

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
MERCEDES BENZ	GL	H	Dual Purpose	-	Yes
MERCEDES BENZ	GLA	C	Lower Medium	-	Yes
MERCEDES BENZ	GLC	H	Dual Purpose	-	Yes
MERCEDES BENZ	GLE	H	Dual Purpose	-	Yes
MERCEDES-AMG	GT	G	Specialist Sports	-	Yes
MERCEDES BENZ	S CLASS	F	Luxury Saloon	-	Yes
MERCEDES BENZ	SPRINTER	V	Van	Yes	-
MG	HS	I	Multi Purpose Vehicle	-	Yes
MG	MG 4	C	Lower Medium	Yes	-
MG	MG 5	D	Upper Medium	Yes	-
MG	ZS	H	Dual Purpose	Yes	-
MIA	MIA	A	Mini	Yes	-
MINI	COOPER	B	Supermini	Yes	-
MINI	COUNTRYMAN	C	Lower Medium	-	Yes
MITSUBISHI	L200	H	Dual Purpose	Yes	-
MITSUBISHI	I-MIEV	A	Mini	Yes	-
MITSUBISHI	OUTLANDER	H	Dual Purpose	-	Yes
NISSAN	ARIYA	H	Dual Purpose	Yes	-
NISSAN	DYNAMO	I	Multi Purpose Vehicle	Yes	-
NISSAN	E-NV200	I	Multi Purpose Vehicle	Yes	-
NISSAN	LEAF	C	Lower Medium	Yes	-
OPEL	AMPERA	D	Upper Medium	-	Yes
OPEL	ASTRA	C	Lower Medium	Yes	Yes
OPEL	COMBO	I	Multi Purpose Vehicle	Yes	-
OPEL	CORSA	B	Supermini	Yes	-
OPEL	GT	G	Specialist Sports	-	Yes
OPEL	GRANDLAND	I	Multi Purpose Vehicle	-	Yes
OPEL	MOKKA	C	Lower Medium	Yes	-
OPEL	VIVARO	V	Van	Yes	-
PEUGEOT	208	B	Supermini	Yes	-
PEUGEOT	308	C	Lower Medium	Yes	Yes
PEUGEOT	408	H	Dual Purpose	-	Yes

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
PEUGEOT	508	D	Upper Medium	-	Yes
PEUGEOT	2008	C	Lower Medium	Yes	-
PEUGEOT	3008	H	Dual Purpose	-	Yes
PEUGEOT	ION	A	Mini	Yes	-
PEUGEOT	RIFTER	V	Van	Yes	-
PEUGEOT	TRAVELLER	V	Van	Yes	-
PORSCHE	918	G	Specialist Sports	-	Yes
PORSCHE	CAYENNE	H	Dual Purpose	-	Yes
PORSCHE	PANAMERA	F	Luxury Saloon	-	Yes
PORSCHE	TAYCAN	G	Specialist Sports	Yes	-
RENAULT	FLUENCE Z.E.	D	Upper Medium	Yes	-
RENAULT	KANGOO	I	Multi Purpose Vehicle	Yes	-
RENAULT	MEGANE	C	Lower Medium	Yes	Yes
RENAULT	TWIZY	A	Mini	Yes	-
RENAULT	CAPTUR	H	Dual Purpose	-	Yes
RENAULT	TWINGO	A	Mini	Yes	-
RENAULT	ZOE	C	Lower Medium	Yes	-
ROLLS ROYCE	SPECTRE	F	Luxury Saloon	Yes	-
SEAT	FORMENTOR	H	Dual Purpose	-	Yes
SEAT	LEON	C	Lower Medium	-	Yes
SEAT	MII	A	Mini	Yes	-
SKODA	CITIGO	A	Mini	Yes	-
SKODA	ENYAQ	H	Dual Purpose	Yes	-
SKODA	OCTAVIA	D	Upper Medium	-	Yes
SKODA	SUPERB	E	Executive	-	Yes
SMART	FORTWO	A	Mini	Yes	-
SMART	FORFOUR	B	Supermini	Yes	-
SMART	SMART #1	C	Lower Medium	Yes	-
SSANGYONG	KORANDO	H	Dual Purpose	Yes	-
SUBARU	SOLTERRA	H	Dual Purpose	Yes	-
SUZUKI	ACROSS	H	Dual Purpose	-	Yes
TESLA	MODEL 3	E	Executive	Yes	-
TESLA	MODEL S	F	Luxury Saloon	Yes	-
TESLA	MODEL X	H	Dual Purpose	Yes	-
TESLA	MODEL Y	H	Dual Purpose	Yes	-

Make	Model	UK Segment	UK Segment Name	BEV	PHEV
TESLA	ROADSTER	G	Specialist Sports	Yes	-
THINK	THINKCITY	A	Mini	Yes	-
TOYOTA	BZ4X	H	Dual Purpose	Yes	-
TOYOTA	PRIUS	C	Lower Medium	-	Yes
TOYOTA	RAV4	H	Dual Purpose	-	Yes
TOYOTA	YARIS	B	Supermini	Yes	-
VOLKSWAGEN	ARTEON	D	Upper Medium	-	Yes
VOLKSWAGEN	E-GOLF	C	Lower Medium	Yes	-
VOLKSWAGEN	E-UP	A	Mini	Yes	-
VOLKSWAGEN	GOLF	C	Lower Medium	-	Yes
VOLKSWAGEN	ID BUZZ	I	Multi Purpose Vehicle	Yes	-
VOLKSWAGEN	ID3	C	Lower Medium	Yes	-
VOLKSWAGEN	ID4	H	Dual Purpose	Yes	-
VOLKSWAGEN	ID5	H	Dual Purpose	Yes	-
VOLKSWAGEN	ID7	E	Executive	Yes	-
VOLKSWAGEN	PASSAT	D	Upper Medium	-	Yes
VOLKSWAGEN	TIGUAN	H	Dual Purpose	-	Yes
VOLKSWAGEN	TOUAREG	H	Dual Purpose	-	Yes
VOLKSWAGEN	UP	A	Mini	Yes	-
VOLVO	C40	C	Lower Medium	Yes	-
VOLVO	EX30	C	Lower Medium	Yes	-
VOLVO	POLESTAR	E	Executive	Yes	Yes
VOLVO	S60	D	Upper Medium	-	Yes
VOLVO	S90	E	Executive	-	Yes
VOLVO	V60	D	Upper Medium	-	Yes
VOLVO	V90	E	Executive	-	Yes
VOLVO	XC40	H	Dual Purpose	Yes	Yes
VOLVO	XC60	H	Dual Purpose	-	Yes
VOLVO	XC90	H	Dual Purpose	-	Yes

Notes: Only includes models with registrations in the UK fleet up to the end of 2023 (DfT, 2024).

5.30. During the derivation of the conversion factors, some discrepancies were found in the EEA CO_2 monitoring databases for the gCO_2/km and Wh/km data for certain models, which were then updated based on other sources of official regulatory type-approval data, for example from manufacturer's websites, EV Database (EV Database, 2023) and the Green Car Guide (Green Car Guide, 2023).

5.31. Consistent with the approach used for the calculation of conversion factors for conventionally fuelled passenger cars, the gCO_2/km and Wh/km figures from type approval with NEDC need adjusting to account for real-world performance (charging losses are already accounted for under the type approval methodology (VDA, 2014)). Several assumptions are therefore made in order to calculate adjusted 'Real-World' energy consumption and emission factors. These assumptions were discussed and agreed with DfT.

5.32. As for conventional vehicles (see earlier section for petrol and diesel cars), there has been a transition from NEDC to the new regulatory test – WLTP, to bring the results of tests under regulatory testing conditions closer to those observed in the real-world. However, the majority of vehicles in the UK fleet are registered before 2020 and so the reported emission and electricity consumption values for BEVs and PHEVs registered before 2020 are still based on the previous NEDC testing regime or both NEDC and WLTP values are provided. Therefore, the GHG CF calculations for xEVs are unchanged for those vehicles registered before 2021. Starting from the 2024 update, xEVs registered from 2021 will be calculated based on WLTP testing regime using real-world uplift factors for WLTP vehicles.

5.33. A further complication for PHEVs is that the real-world electric range is lower than that calculated on the standard regulatory testing protocol, which also needs to be accounted for in the assumption of the average share of total km running on electricity. Figure 4 illustrates the utility function used to calculate the share of electric km based on the electric range of a PHEV. Real-World factors for average gCO2/km and Wh/km for PHEVs are therefore further adjusted based on the ratio of calculated electric shares of total km under Test-Cycle and Real-World conditions. This utility function was updated in the 2025 Conversion Factors update, to better reflect the actual share of electric km in real-world. Table 19 summarises (i) the assumption of the real-world average percentage share of total km running on electricity (battery mode) and fuel combustion mode, and (ii) the CO_2 emissions per kilometre for PHEV cars, accounting for both the real-world percentage share of electric (battery mode) and fuel combustion mode kilometres.

5.34. The key assumptions used in the calculation of adjusted Real-World gCO_2/km and Wh/km figures are summarised in Table 20. The calculated real-world figures for individual vehicle models are used to calculate the final registrations-weighted average factors for different vehicle segments/sizes. These are then combined with other GHG Conversion factors to calculate the final set of conversion factors for different Scopes/reporting tables (i.e. as summarised in earlier Table 17).

Table 19: PHEV Cars Real-World average percentage share of Electric and Combustion Mode kilometres, and CO_2 Emissions per kilometre, based on 2023 UK fuel, electricity, and PHEV car fleet data, per market segment

PHEV Cars by Market segment	Power-train Type	% of Real-World Electric (Battery Mode) km	% of Real-World Fuel Combustion Mode km	CO_2 Emissions from Battery Mode ($kgCO_2/km$)	CO_2 Emissions from Fuel Combustion Mode ($kgCO_2/km$)
Mini	PHEV	29%	71%	-	-
Supermini	PHEV	29%	71%	0.03	0.03
Lower Medium	PHEV	29%	71%	0.01	0.07
Upper Medium	PHEV	29%	71%	0.01	0.08
Executive	PHEV	22%	78%	0.01	0.08
Luxury Saloon	PHEV	22%	78%	0.01	0.11
Specialist Sports	PHEV	22%	78%	0.01	0.14
Dual Purpose	PHEV	34%	66%	0.01	0.10
Multi-Purpose Vehicle	PHEV	34%	66%	0.02	0.08

Table 20: Summary of key data elements, sources and key assumptions used in the calculation of GHG conversion factors for electric cars and vans

Data type	Raw data source	Other notes
Numbers of registrations of different vehicle types/models	Data for 2010-2020 cars and vans: • EEA CO_2 monitoring databases Data for 2021 cars and vans: • VCA regulatory databases (VCA, 2023) Data for 2023 cars and vans: • UK DfT's vehicle licensing statistics data file VEH_0270 (DfT, 2024)	This data is used in conjunction with CO_2/km and Wh/km data to calculate registrations-weighted average figures by market segment or vehicle size category.
CO_2 emissions from petrol or diesel fuel use per km (test-cycle)	Data for 2010-2020 cars and vans: • EEA CO_2 monitoring databases Data for 2021and 2022 cars and vans: • VCA regulatory databases (VCA, 2023)	Zero for BEVs. For PHEVs, the conversion factors are for the average share of km driven in charge-sustaining mode / average liquid fuel consumption per km.
Wh electricity consumption per km (test-cycle)	As for CO_2 emissions	Average electricity consumption per average km (i.e. factoring in for PHEVs that only a fraction of total km will be in electric mode).
Test-Cycle to Real-World conversion for gCO_2 / km	Assumption based on literature, consistent with the source used for the car EFs for conventional powertrains.	For NEDC: • An uplift of **35%** is applied to the test-cycle emission component For WLTP: • An uplift of **23.7%** is applied to the test-cycle emission component

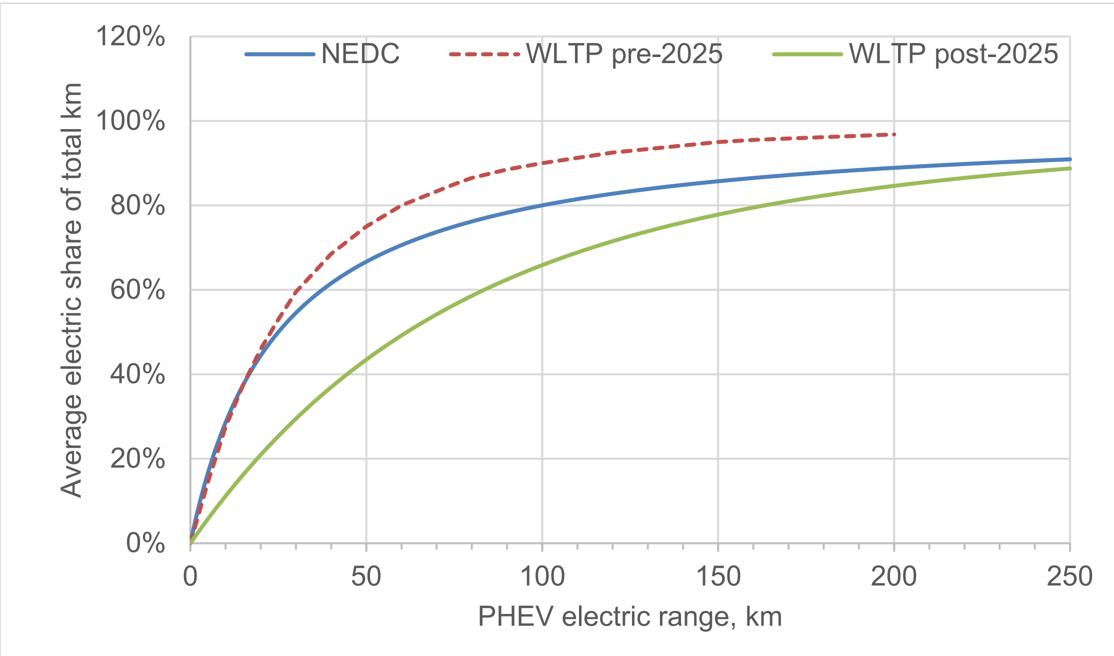
Data type	Raw data source	Other notes
Test-Cycle to Real-World conversion for Wh per km	Assumption based on best available information on the average difference between test-cycle and real-world performance	For NEDC: • An uplift of **40%** is applied to the test-cycle electrical energy consumption component. This is consistent with the uplift currently being used in the analysis for the EC DG CLIMA, developed/agreed with the EC's JRC. For WLTP: • An uplift of **12% to 20%** is applied to the test-cycle electrical energy consumption component.
Electric range for PHEVs under Test-Cycle conditions	Available from various public sources for specific models	Values representative of the models currently available on the market are used, i.e. generally between 30-50km. The notable exception is the BMW i3 REX, which was 200km up to 2015.
Electric range for PHEVs under Real-World conditions	Calculated based on Test-Cycle electric range and Test-Cycle to Real-World conversion for Wh per km	Calculated based on Test-Cycle electric range and Test-Cycle to Real-World conversion for Wh/km
Share of electric km on Test-Cycle	Calculated using the standard formula used in type-approval*: **Electric km %** = 1 – (25 / (25 + Electric km range))	Uses Test-Cycle electric range in km
Share of electric km in Real-World conditions	Calculated using the equation in Annexes 4-15 of "*Commission Regulation (EU) 2017/1151 as regards the emission type approval procedures for light passenger and commercial vehicles*"[20]	Uses Real-World electric range in km

[20] https://ec.europa.eu/transparency/comitology-register/screen/documents/082562/1/consult?lang=en

Data type	Raw data source	Other notes
Loss factor for electric charging	N/A	Charging losses are already accounted for under the type approval testing protocol in the Wh/km dataset.
GHG conversion factors for electricity consumption	UK electricity conversion factors ($kgCO_2e$ / kWh): • Electricity generated • Electricity T&D • WTT electricity generated • WTT electricity T&D	From the UK GHG Conversion factors model outputs for UK Electricity
CH_4, N_2O and WTT CO_2e emissions from petrol /diesel use	Calculated based on derived Real-World g/km for petrol /diesel.	Calculation uses GHG Conversion factors for petrol/diesel: uses the ratio of direct CO_2 emission component to CH_4, N_2O or WTT CO_2e component for petrol/diesel.

Notes: * the result of this formula is illustrated in Figure 4 below.

Figure 4: Illustration of the relationship of electric range to average electric share of total km for PHEVs assumed in the calculations



Notes: NEDC's curve calculated by Ricardo based on the standard formula: Electric km % = 1 – (25 / (25 + Electric km range)). WLTP pre-2025 curve calculated by Ricardo based on the equation in Sub-Annex 8 Appendix 5 of "*Commission Regulation (EU) 2017/1151*". WLTP post-2025 curve calculated by Ricardo based on the equation in Annexes 4-15 of "*Commission Regulation (EU) 2017/1151 as regards the emission type approval procedures for light passenger and commercial vehicles*"

Conversion factors by Passenger Car Market Segments

5.35. For the 2025 GHG Conversion factors, the market classification split (according to SMMT classifications) was derived using detailed SMMT data on new car registrations between 2006 and 2024 split by fuel (Table 21) and again combining this with information extracted from the 2021 ANPR dataset. Adjustment factors are then applied to consider ‘real-world’ impacts and the biofuel content of fuels, consistent with the methodology used to derive the car engine size emission factors.

5.36. Conversion factors for CH_4 and N_2O are based on the emission factors from the UK GHGI 2019 (Ricardo Energy & Environment, 2021) and updated to align with AR5 GWP values. The emission factors used in the UK GHGI are based on COPERT 5 version 6 (EMISIA, 2022).

5.37. The supplementary market segment based conversion factors for passenger cars are presented in the ‘Passenger vehicles’ and ‘Business travel- land’ worksheets of the 2025 GHG Conversion factors set.

Table 21: Average car CO_2 conversion factors and total registrations by market segment for 2008 to 2024 (based on data sourced from SMMT)

Fuel Type	Market Segment	Example Model	NEDC* gCO_2 per km	WLTP gCO_2 per km	Registrations	% Total
Diesel	A. Mini	Smart Fortwo	90.0	N/A	7,493	0.1%
	B. Super Mini	VW Polo	104.7	119.9	1,409,776	10.80%
	C. Lower Medium	Ford Focus	112.5	130.4	3,671,695	28.13%
	D. Upper Medium	Toyota Avensis	126.6	147.1	2,307,280	17.68%
	E. Executive	BMW 5-Series	133.5	152.5	1,140,383	8.74%
	F. Luxury Saloon	Bentley Continental GT	162.8	178.7	64,494	0.49%
	G. Specialist Sports	Mercedes CLS	134.8	180.2	115,061	0.88%
	H. Dual Purpose	Land Rover Discovery	153.6	180.5	3,262,750	25.00%
	I. Multi-Purpose	Renault Espace	138.0	173.4	1,074,608	8.23%
	All	**Total**	**128.7**	**165.2**	**13,053,540**	**100%**
Petrol	A. Mini	Smart Fortwo	107.5	122.2	783,216	4.01%
	B. Super Mini	VW Polo	118.7	127.2	9,901,589	50.68%

Fuel Type	Market Segment	Example Model	NEDC* gCO_2 per km	WLTP gCO_2 per km	Registrations	% Total
	C. Lower Medium	Ford Focus	136.0	141.7	5,171,850	26.47%
	D. Upper Medium	Toyota Avensis	159.0	162.6	798,087	4.08%
	E. Executive	BMW 5-Series	166.1	185.2	270,761	1.39%
	F. Luxury Saloon	Bentley Continental GT	257.3	274.6	44,387	0.23%
	G. Specialist Sports	Mercedes CLS	192.1	219.1	478,273	2.45%
	H. Dual Purpose	Land Rover Discovery	155.6	172.4	1,626,829	8.33%
	I. Multi-Purpose	Renault Espace	152.8	147.7	463,760	2.37%
	All	**Total**	**130.4**	**143.7**	**19,538,752**	**100%**
Unknown Fuel (Diesel + Petrol)	A. Mini	Smart Fortwo	107.2	122.2	790,709	2.43%
	B. Super Mini	VW Polo	116.6	127.1	11,311,365	34.71%
	C. Lower Medium	Ford Focus	124.3	140.6	8,843,545	27.13%
	D. Upper Medium	Toyota Avensis	133.7	156.5	3,105,367	9.53%
	E. Executive	BMW 5-Series	139.7	167.0	1,411,144	4.33%
	F. Luxury Saloon	Bentley Continental GT	199.9	237.7	108,881	0.33%
	G. Specialist Sports	Mercedes CLS	179.5	218.5	593,334	1.82%
	H. Dual Purpose	Land Rover Discovery	154.6	175.6	4,889,579	15.00%
	I. Multi-Purpose	Renault Espace	142.5	166.6	1,538,368	4.72%
	All	**Total**	**129.5**	**147.0**	**32,592,292**	**100%**

* For 2019 and 2018, NEDCe reported data is converted to NEDC, based on an estimated 9% correlation factor from SMMT based on analysis of vehicle models where both NEDC and NEDCe values exist. NEDCe (NEDC equivalent) data are officially reported figures calculated from WLTP using an official regulatory correlation tool. They are used to check compliance of new vehicle registrations with the EU-wide regulatory CO_2 targets set on NEDC basis.

Direct Emissions from Taxis

5.38. The conversion factors for black cabs are based on data provided by Transport for London (TfL)[21] on the testing of emissions from black cabs using real-world London Taxi cycles, and an average passenger occupancy of 1.5 (average 2.5 people per cab, including the driver) from LTI, 2007 – a more recent source has not yet been identified. This methodology accounts for the significantly different operational cycle of black cabs/taxis in the real world when compared to the NEDC (official vehicle type-approval) values, which significantly increases the emission factor (by ~40% vs NEDC).

5.39. The conversion factors (per passenger km) for regular taxis were estimated based on the average type-approval CO_2 factors for medium and large cars, uplifted by the same factor as for black cabs (i.e. 40%, based on TfL data) to reflect the difference between the type-approval figures and those operating a real-world taxi cycle (i.e. based on different driving conditions to average car use), plus an assumed average passenger occupancy of 1.4 (L.E.K. Consulting, 2002).

5.40. Conversion factors per passenger km for taxis and black cabs are presented in the ‘Business travel- land’ worksheet of the 2025 GHG Conversion factors set. The base conversion factors per vehicle km are also presented in the ‘Business travel- land’ worksheet of the 2025 GHG Conversion factors set.

5.41. Conversion factors for CH_4 and N_2O are based on the conversion factors for diesel cars from the UK GHGI 2019 (Ricardo Energy & Environment, 2021), updated to align with AR5 GWP values and are presented together with the overall total conversion factors in the ‘Business travel- land’ worksheet of the 2025 GHG Conversion factors set.

5.42. It should be noted that the current conversion factors for taxis do not take into account emissions spent from “cruising” for fares. Currently, robust data sources do not exist that could inform such an "empty running" factor. If suitably robust sources are identified in the future, the methodology for taxis may be revisited and revised in a future update to account for this.

Direct Emissions from Vans/Light Goods Vehicles (LGVs)

5.43. Average conversion factors by fuel, for vans/light good vehicles (LGVs: N1 vehicles, vans up to 3.5 tonnes gross vehicle weight - GVW) and by size (Class I, II or III) are presented in Table 22 and in the “Delivery vehicles” worksheet of the 2025 GHG Conversion factors set.

5.44. Conversion factors for petrol and diesel vans/LGVs are based upon emission factors and vehicle km for average sized LGVs from the UK GHGI for 2023. The factors for each class are then calculated relative to the average from quantitative analysis of regulatory data across the years 2012-2023. For the years 2012-2020 CO_2 emissions factors for different size classes were derived from analysis of the EEA dataset, as detailed in previous updates. This dataset is no longer published

[21] The data was provided by TfL in a personal communication and is not available in a public TfL source.

by the EEA for UK vehicles, so an alternative approach was developed. In the previous publication (GHG CF, 2023) the 2021 regulatory data was derived from new LGV registrations from the UK DfT table VEH0160_GB (DfT and DVLA, 2024) matched with reference weight and emissions data from the 2020 EEA database. Responsibility for the publication of the UK vehicle regulatory data has now transferred from the EEA to the UK Vehicle Certification Agency (VCA) with the data expected to be published annually. As of the time of this publication only the 2021 data (VCA, 2023) as available, therefore, a similar approach has been taken to the previous update, 2023 vehicle registration statistics from DfT table VEH0160_GB (DfT and DVLA, 2024) is matched with reference weight and emissions data from the 2021 VCA regulatory dataset. Missing data for models with a high number of registrations is gap filled using data obtained from manufacturers websites where possible. The conversion factors are further uplifted by 15% to represent ‘real-world’ emissions (i.e. also factoring in typical vehicle loading versus unloaded test-cycle based results), consistent with the previous approach used for cars, and agreed with DfT in the absence of a similar time-series dataset of ‘real-world’ vs type-approval emissions from vans (see earlier section on passenger cars). In a future update, it is envisaged this uplift will be further reviewed.

5.45. The dataset used to allocate different vehicles to each van class is based on a reference weight (approximately equivalent to kerb weight plus 60kg) provided in the VCA van CO_2 monitoring database (VCA, 2023) and are carried over from the 2021 in the absence of new 2022 data, on the assumption that there is unlikely to be significant changes in reference weight on a model by model basis from the previous year. The dataset holds a variety of information about new vans registered in 2021 (the most recent year available) and is used to derive the split of petrol and diesel van stock between size classes, as well as the CO_2 emissions performance of different petrol/diesel van size categories. Importantly, this dataset is also the basis of the average van loading capacity calculations (see later section on van freight emission factors) and has replaced the dataset previously published by the EEA. It is not yet clear, given the VCA has recently taken over publication of the regulatory data, whether the most recent year required for the Conversion Factors (2 years in arrears) will be available for future years, or if vehicle registrations from the DfT will continue to be needed for the latest year. In the 2025 update, CO_2 conversion factors for CNG and LPG vans are calculated from the conversion factors for conventionally fuelled vans using the same methodology as for passenger cars (section 5.21). The average van conversion factor is calculated based on the relative UK GHGI vehicle km for petrol and diesel vans for 2023, as presented in Table 22.

5.46. Conversion factors for CH_4 and N_2O are based on the conversion factors from the UK GHG Inventory 2019 (Ricardo Energy & Environment, 2021) and updated to align with AR5 GWP values.

5.47. As a final additional step, an accounting for biofuel use has been included in the calculation of the final vans/LGVs emission factors.

Table 22: New conversion factors for vans for the 2025 GHG Conversion factors

Van fuel	Van size	Direct gCO_2e per km				vkm	Payload Capacity
		CO_2	CH_4	N_2O	Total	% split	Tonnes
Petrol (Class I)	Up to 1.305 tonne	201.2	0.2	0.5	201.9	29.5%	0.38
Petrol (Class II)	1.305 to 1.740 tonne	208.0	0.2	0.5	208.8	65.4%	0.70
Petrol (Class III)	Over 1.740 tonne	337.7	0.2	0.5	338.5	5.1%	0.98
Petrol (average)	**Up to 3.5 tonne**	**212.7**	**0.2**	**0.5**	**213.4**	**100.0%**	**0.62**
Diesel (Class I)	Up to 1.305 tonne	155.7	0.0	1.9	157.6	2.4%	0.49
Diesel (Class II)	1.305 to 1.740 tonne	190.9	0.0	1.9	192.8	23.5%	0.84
Diesel (Class III)	Over 1.740 tonne	277.1	0.0	1.9	279.0	74.1%	1.08
Diesel (average)	**Up to 3.5 tonne**	**254.0**	**0.0**	**1.9**	**255.8**	**100.0%**	**1.01**
LPG	Up to 3.5 tonne	275.6	0.0	0.6	276.2	**100.0%**	1.00
CNG	Up to 3.5 tonne	249.3	1.2	0.6	251.0	**100.0%**	1.00
Average		**252.7**	**0.0**	**1.8**	**254.5**	**100.0%**	**1.00**

Plug-in Hybrid Electric and Battery Electric Vans (xEVs)

5.48. As outlined earlier for cars, since the number of electric cars and vans (xEVs[22]) in the UK fleet is rapidly increasing, there is now a need to include specific conversion factors for such vehicles to complement the existing conversion factors for other vehicle types.

5.49. The methodology, data sources and key assumptions utilised in the development of the conversion factors for xEVs are the same for vans as outlined earlier for cars.

5.50. It should be noted that only models with registrations in the UK fleet up to the end of 2022 are included in the model.

5.51. Table 23 provides a summary of the van models registered into the UK market by the end of 2023 (the most recent data year for the source UK DfT's vehicle

[22] xEVs is a generic term used to refer collectively to battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), range-extended electric vehicles (REEVs, or ER-EVs, or REX) and fuel cell electric vehicles (FCEVs).

licensing statistics data file VEH_0270 (DfT, 2024) at the time of the development of the 2025 GHG Conversion factors). At this point, the vast majority of models registered are battery electric vehicles (BEV) and so only BEVs are considered in the conversion factors. Plug-in hybrid electric vehicle (PHEV) registrations are expected to increase in the EEA database and a methodology will be developed to accommodate them in future updates to the conversion factors.

Table 23: xEV van models and their allocation to different size categories

Make	Model	Van Segment	BEV	PHEV
ADDAX	MT	Class I	Yes	-
ALKE	ATX	Class I	Yes	-
BYD	ETP3	Class III	Yes	-
CENNTRO	METRO	Class I	Yes	-
CITROEN	BERLINGO	Class II	Yes	-
CITROEN	E-DISPATCH	Class III	Yes	-
CITROEN	RELAY	Class III	Yes	-
DFSK	EC31	Class II	Yes	-
DFSK	EC35	Class II	Yes	-
ETESIA	ET LANDER	Class I	Yes	-
FIAT	DOBLO	Class II	Yes	-
FIAT	DUCATO	Class III	Yes	-
FIAT	SCUDO	Class III	Yes	-
FORD	TRANSIT CONNECT	Class III	Yes	-
FORD	TRANSIT-CUSTOM	Class III	-	Yes
GOUPIL	G4	Class I	Yes	-
IVECO	DAILY	Class III	Yes	-
LDV	V80	Class III	Yes	-
LONDON EV COMPANY	VN5	Class III	-	Yes
MAN	ETGE	Class III	Yes	-
MAXUS	T90 EV	Class III	Yes	-
MERCEDES	VITO	Class III	Yes	-
MERCEDES	ESPRINTER	Class III	Yes	-
MERCEDES	ECITAN	Class II	Yes	-
MERCEDES	EVITO	Class III	Yes	-
MIA	MIA	Class I	Yes	-
NISSAN	E-NV200	Class II	Yes	-
NISSAN	TOWNSTAR	Class II	Yes	-
OPEL	COMBO	Class III	Yes	-
OPEL	VIVARO	Class III	Yes	-
PEUGEOT	E-BOXER	Class III	Yes	-
PEUGEOT	EXPERT	Class III	Yes	-
PEUGEOT	PARTNER	Class II	Yes	-
RENAULT	MASTER	Class III	Yes	-

Make	Model	Van Segment	BEV	PHEV
RENAULT	KANGOO	Class II	Yes	-
RENAULT	ZOE	Class II	Yes	-
SAIC MAXUS	E DELIVER	Class II	Yes	-
SAIC MAXUS	V80	Class III	Yes	-
TATA	ACE	Class I	Yes	-
TOYOTA	PROACE	Class III	Yes	-
VOLKSWAGEN	ETRANSPORTER	Class III	Yes	-
VOLKSWAGEN	ID BUZZ	Class III	Yes	-

Notes: Only includes models with registrations in the UK fleet up to the end of 2023

5.52. All other methodological details are as already outlined for xEV passenger cars.

Direct Emissions from Buses

5.53. The 2015 and earlier updates used data from DfT from the Bus Service Operators Grant (BSOG) in combination with DfT bus activity statistics (vehicle km, passenger km, average passenger occupancy) to estimate conversion factors for local buses. DfT holds very accurate data on the total amount of money provided to bus service operators under the scheme, which provides a fixed amount of financial support per unit of fuel consumed. Therefore, the total amount of fuel consumed (and hence CO_2 emissions) could be calculated from this, which when combined with DfT statistics on total vehicle km, bus occupancy and passenger km allow the calculation of emission factors[23].

5.54. From the 2016 update onwards, it was necessary to make some methodological changes to the calculations due to changes in the Scope/coverage of the underlying DfT datasets, which include:

a) BSOG data are now only available for commercial services, and not also for local authority supported services.
b) BSOG data are now only available for England, outside of London: i.e. data are no longer available for London, due to a difference in how funding for the city is managed/provided, nor for other parts of the UK.

5.55. The conversion factors for buses account for additional direct CO_2 emissions from the use of selective catalytic reduction (SCR). This technology uses a urea solution (also known as 'AdBlue') to effectively remove NO_x and NO_2 from diesel engines' exhaust gases; this process occurs over a specially formulated catalyst. The urea solution is injected into the vehicles' exhaust system before harmful NO_x emissions are generated from the tail pipe. When the fuel is burnt, urea solution is injected into the SCR catalyst to convert the NO_x into a less harmful mixture of nitrogen and water vapour; small amounts of carbon dioxide are also produced as a result of this reaction. Emissions from the consumption of urea in buses have

[23] The robustness of the BSOG data has reduced over the years because of the changes to the way BSOG is paid to operators and local authorities. Approximations have been made in recent update years where data was not available (based on previous year data) and a revised methodology has commenced from 2016.

been included in the estimates for overall CO_2 conversion factors for buses. A summary of the key assumptions used in the calculation of emissions from urea is provided in the following Table 24. These are based on assumptions in the EMEP/EEA Emissions Inventory Guidebook (EEA, 2019).

Table 24: Key assumptions used in the calculation of CO_2 emissions from Urea (aka 'AdBlue') use

	CO_2 EF for urea consumption ($kgCO_2$ /kg urea solution)1	Percentage of vehicles using urea	Urea consumption rate as a percentage of fuel consumed by vehicles using urea
Euro IV	0.238	75%	4%
Euro V	0.238	75%	6%
Euro VI	0.238	100%	3.5%

Notes: [1]Assumes 32.5% (by mass) aqueous solution of urea

5.56. Briefly, the main calculation for local buses can be summarised as follows:

a) Total fuel consumption (Million litres) = Total BSOG (£million) / BSOG fuel rate (p/litre) x 100
b) Total bus passenger-km (Million pkm) = Total activity (Million vkm) x Average bus occupancy (#)
c) Average fuel consumption (litres/pkm) = Total fuel consumption / Total bus passenger-km
d) Average bus emission factor = Average fuel consumption x Fuel Emission Factor ($kgCO_2e$/litre) + Average Emission Factor from Urea Use

5.57. As a final additional step, biofuel use is accounted for in the final bus emission factors.

5.58. Conversion factors for coach services were estimated based on figures from National Express, who provide the majority of scheduled coach services in the UK.

5.59. Conversion factors for CH_4 and N_2O are based on the conversion factors from the UK GHG Inventory 2019 and updated to align with AR5 GWP values. These factors are also presented together with an overall total factor in Table 25.

5.60. Table 25 gives a summary of the 2025 GHG Conversion factors and average passenger occupancy. It should also be noted that fuel consumption and conversion factors for individual operators and services will vary significantly depending on the local conditions, the specific vehicles used and on the typical occupancy achieved.

Table 25: Conversion factors for buses for the 2025 GHG Conversion factors

Bus type	Average passenger occupancy	gCO2e per passenger km			
		CO_2	CH_4	N_2O	Total
Local bus (not London)	10.95	124.35	0.02	0.88	125.25
Local London bus	17.24	68.27	0.01	0.47	68.75
Average local bus	12.71	103.11	0.01	0.73	103.85
Coach	17.56	27.27	0.01	0.48	27.76

Notes: Average load factors/passenger occupancy mainly taken from DfT Bus statistics, Table BUS0304 "Average bus occupancy on local bus services by metropolitan area status and country: Great Britain, annual from 2004/05". * Combined figure based on data from DfT for non-local buses and coaches combined calculated based on an average of the last 5 years for which this was available (up to 2007). Actual occupancy for coaches alone is likely to be significantly higher.

Direct Emissions from Motorcycles

5.61. Motorcycles factors remain constant since the publication of 2021 GHG Conversion factors but were updated to align with AR5 instead of AR4 GWP values in the 2023 update.

5.62. Data from type approval is not currently readily available for motorbikes and CO_2 emission measurements were only mandatory in motorcycle type approval from 2005.

5.63. Conversion factors for motorcycles are split into 3 categories:

a) Small motorbikes (mopeds/scooters up to 125cc);
b) Medium motorbikes (125-500cc); and
c) Large motorbikes (over 500cc).

5.64. The conversion factors are calculated based on a large dataset kindly provided by (Clear, 2008)[24], based on a mix of magazine road test reports and user reported data. A summary is presented in Table 26, with the corresponding complete conversion factors developed for motorcycles presented in the 'Passenger vehicles' worksheet of the 2025 GHG Conversion factors set. The total average has been calculated weighted by the relative number of registrations of each category according to DfT licencing statistics for 2019 (DVLA, 2020).

5.65. These conversion factors are based predominantly on data derived from real-world riding conditions (rather than test-cycle based data) and are therefore likely to be more representative of typical in-use performance. The average difference between the factors based on real-world observed fuel consumption and other figures based upon test-cycle data from the European Motorcycle Manufacturers Association (ACEM) (+9%) is smaller than the corresponding differential

[24] Dataset of motorcycle fuel consumption compiled by Clear (https://clear.eco/) for the development of its motorcycle CO_2 model used in its carbon offsetting products.

previously used to uplift cars and vans test cycle data to real-world equivalents (+15%).

5.66. Conversion factors for CH_4 and N_2O are based on the conversion factors from the UK GHGI 2019 (Ricardo Energy & Environment, 2021) and have been updated to align with AR5 GWP values. These factors are also presented together with overall total conversion factors in the “Passenger vehicles”, “Business travel - land”, and “Managed assets- vehicles” worksheets of the 2025 GHG Conversion factors set.

Table 26: Summary dataset on CO_2 emissions from motorcycles based on detailed data provided by Clear (2008)

CC Range	Model Count	Number	Av. gCO_2/km	Av. MPG*
Up to 125cc	24	58	85.0	77.3
125cc to 200cc	3	13	77.8	84.4
200cc to 300cc	16	57	93.1	70.5
300cc to 400cc	8	22	112.5	58.4
400cc to 500cc	9	37	122.0	53.9
500cc to 600cc	24	105	139.2	47.2
600cc to 700cc	19	72	125.9	52.2
700cc to 800cc	21	86	133.4	49.3
800cc to 900cc	21	83	127.1	51.7
900cc to 1000cc	35	138	154.1	42.6
1000cc to 1100cc	14	57	135.6	48.5
1100cc to 1200cc	23	96	136.9	48.0
1200cc to 1300cc	9	32	136.6	48.1
1300cc to 1400cc	3	13	128.7	51.1
1400cc to 1500cc	61	256	132.2	49.7
1500cc to 1600cc	4	13	170.7	38.5
1600cc to 1700cc	5	21	145.7	45.1
1700cc to 1800cc	3	15	161.0	40.8
1800cc to 1900cc	0	0		0.0
1900cc to 2000cc	0	0		0.0
2000cc to 2100cc	1	5	140.9	46.6
<125cc	24	58	85.0	77.3
126-500cc	36	129	103.2	63.7
>500cc	243	992	137.2	47.9
Total	303	1179	116.9	56.2

Note: Summary data based on data provided by Clear (https://clear.eco/) from a mix of magazine road test reports and user reported data. * MPG has been calculated from the supplied gCO_2/km dataset, using the fuel properties for petrol from the latest conversion factors dataset.

Direct Emissions from Passenger Rail

5.67. Conversion factors for passenger rail services remain constant since the publication of 2021 GHG Conversion factors but have been updated to align with AR5 instead of AR4 GWP values in the 2023 update. These factors are provided in the “Business travel – land” worksheet of the 2025 GHG Conversion factors set. These include updates to the national rail, international rail (Eurostar), light rail schemes and the London Underground. These factors are based on the assumptions outlined in the following paragraphs. Note that all references to occupancy, passenger numbers/km data and another ridership associated data is based on 2019 rather than 2020 data as it is less unaffected by the COVID-19 pandemic.

International Rail (Eurostar)

5.68. The international rail factor is based on a passenger-km weighted average of the conversion factors for the following Eurostar routes: London-Brussels, London-Paris, London-Marne Le Vallee (Disney), London-Avignon, London-Amsterdam and the ski train from London to Bourg St Maurice[25]. The conversion factors were provided by Eurostar for the 2021 update, together with information on the basis of the electricity figures used in their calculation.

5.69. The methodology used to calculate the Eurostar conversion factors currently uses 3 key pieces of information:

a) Total electricity use by Eurostar trains on the UK and France/Belgium track sections;
b) Total passenger numbers (and therefore calculated passenger km) on all Eurostar services;
c) Conversion factors for electricity (in $kgCO_2$ per kWh) for the UK and France/Belgium journey sections. These are based on the UK grid average electricity from the GHG Conversion factors and the France/Belgium grid averages from the last freely available version of the IEA CO_2 Emissions from Fuel Combustion highlights dataset (from 2013).

5.70. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors, but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors were estimated from the corresponding conversion factors for electricity generation, proportional to the CO_2 emission factors.

National Rail

5.71. The national rail factor refers to an average emission per passenger kilometre for diesel and electric trains in 2020-21. The factor is sourced from information from the Office of the Rail Regulator’s National rail trends for 2019-20 (ORR, 2020). This has been calculated based on total electricity and diesel consumed by the railway for the year sourced from the Association of Train Operating Companies

[25] Although there are now also direct Eurostar routes to Lyon and Marseille, information relating to these routes has not been provided in 2019.

(ATOC), and the total number of passenger kilometres (from National Rail Trends).

5.72. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors, but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors were estimated from the corresponding emissions factors for electricity generation and diesel rail from the UK GHG Inventory 2021, proportional to the CO_2 emission factors. The conversion factors were calculated based on the relative passenger km proportions of diesel and electric rail provided by DfT for 2006-2007 (since no newer datasets are available from DfT).

Light Rail

5.73. The light rail factors were based on an average of factors for a range of UK tram and light rail systems, as detailed in Table 27.

5.74. Figures for the London Overground, London Tramlink and Docklands Light Railway (DLR) are based on factors kindly provided by TfL for 2018/19, adjusted to the new 2022 grid electricity CO_2 emission factor.

5.75. The factors for Midland Metro, Tyne and Wear Metro, Manchester Metrolink and Sheffield Supertram were calculated based on annual passenger km data from DfT's Light rail and tram statistics (DfT, 2020a) and the new 2021 grid electricity CO_2 emission factor.

5.76. The factor for the Glasgow Underground was calculated based on the annual passenger km data from DfT's Glasgow Underground statistics, and the new 2021 grid electricity CO_2 emission factor.

5.77. The average emission factor for light rail and tram was estimated based on the relative passenger km of the eight different rail systems (see Table 27).

5.78. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors were estimated from the corresponding emissions factors for electricity generation, proportional to the CO_2 emission factors.

Table 27: GHG emission factors, electricity consumption and passenger km for different tram and light rail services

	Type	Electricity use	gCO_2e per passenger km				Million pkm
		kWh/pkm	CO_2	CH_4	N_2O	Total	
DLR (Docklands Light Rail)	Light Rail	0.109	22.74	0.10	0.17	23.01	620.70
Glasgow Underground	Light Rail	0.164	34.29	0.15	0.26	34.70	40.70

	Type	Electricity use	gCO_2e per passenger km				Million pkm
		kWh/pkm	CO_2	CH_4	N_2O	Total	
Midland Metro	Light Rail	0.135	28.24	0.12	0.21	28.57	84.30
Tyne and Wear Metro	Light Rail	0.233	48.61	0.21	0.36	49.19	289.10
London Overground	Light Rail	0.109	22.83	0.10	0.17	23.10	1,285.05
London Tramlink	Tram	0.119	24.85	0.11	0.19	25.14	149.19
Manchester Metrolink	Tram	0.078	16.37	0.07	0.12	16.56	463.00
Supertram	Tram	0.350	73.05	0.32	0.55	73.92	68.20
Average*		0.124	25.85	0.11	0.19	26.16	3000

Notes: * Weighted by relative passenger km

London Underground

5.79. The London Underground rail factor was provided from TfL, which was based on the 2019 UK electricity emission factor, so was therefore adjusted to be consistent with the 2022 grid electricity CO_2 emission factor.

5.80. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors, but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors were estimated from the corresponding emissions factors for electricity generation, proportional to the CO_2 emission factors.

Indirect/WTT Emissions from Passenger Land Transport

Cars, Vans, Motorcycles, Taxis, Buses and Ferries

5.81. Indirect/WTT conversion factors for cars, vans, motorcycles, taxis, buses and ferries include only emissions resulting from the fuel lifecycle (i.e. production and distribution of the relevant transport fuel). These indirect/WTT conversion factors were derived using simple ratios of the direct CO_2 conversion factors and the indirect/WTT conversion factors for the relevant fuels from the “Fuels” worksheet, and applying the same ratios to the corresponding direct CO_2 conversion factors for vehicle types using these fuels. Indirect/WTT conversion factors are shown in the “Passenger vehicles”, “Business travel – land” and “Business travel – air” worksheets in the 2025 GHG Conversion factors set.

Rail

5.82. Indirect/WTT conversion factors for international rail (Eurostar), light rail and the London Underground were derived using a simple ratio of the direct CO_2 conversion factors and the indirect/WTT conversion factors for grid electricity from the “UK Electricity” worksheet and the corresponding direct CO_2 conversion factors for vehicle types in the “Passenger vehicles”, “Business travel – land” and “Business travel – air” worksheets in the GHG Conversion factors set.

5.83. The conversion factors for National rail services are based on a mixture of emissions from diesel and electric rail. Indirect/WTT conversion factors were therefore calculated from corresponding estimates for diesel and electric rail combined using relative passenger km proportions of diesel and electric rail provided by DfT for 2006-7 (no newer similar dataset is available).

6. Freight Land Transport Emission Factors

Section summary

6.1. This section describes the calculation of the conversion factors for the transport of freight on land (road and rail). Scope 1 factors included are for delivery vehicles owned or controlled by the reporting organisation. Scope 3 factors are described for freighting goods over land through a third-party company, including factors for both the whole vehicle's load of goods, or per tonne of goods shipped. WTT factors for both delivery vehicles owned by the reporting organisation and for freighting goods via a third party. Factors for managed assets (vans/LGVs, HGVs) are also detailed in this section.

6.2. Table 28 shows where the related worksheets to the freight land transport conversion factors are available in the online spreadsheets of the UK GHG Conversion factors set.

Table 28 Related worksheets to freight land transport emission factors

Worksheet name	Full set	Condensed set
Delivery vehicles	Y	N
Freighting goods*	Y	Y
WTT – delivery vehicles & freight*	Y	N
Managed assets – vehicles**	Y	Y

Note: * vans, HGVs and rail only; ** vans and HGVs only

Summary of changes since the previous update

6.1. There were no major methodological changes in the 2025 update.

Direct Emissions from Heavy Goods Vehicles (HGVs)

6.2. The HGV factors are based on road freight statistics from the Department for Transport (DfT, 2024a) for Great Britain (GB), from a survey on different sizes of rigid and articulated HGVs in the fleet in 2022. The statistics on fuel consumption figures (in miles per gallon) have been estimated by DfT from the survey data. For the 2025 update, these are combined with test data from the European ARTEMIS[26] project showing how fuel efficiency, and therefore the CO_2 emissions, varies with vehicle load.

[26] Artemis (Advanced Research & Technology for EMbedded Intelligent Systems) is the association for actors in Embedded Intelligent Systems within Europe, https://artemis-ia.eu/

6.3. The miles per gallon (MPG) figures in Table RFS0141 (DfT, 2017) are converted to gCO_2 per km factors using the standard fuel conversion factor for diesel in the 2025 GHG Conversion factors. Table RFS0125(DfT, 2024a) shows the percent loading factors are on average between c. 35-80% in the UK HGV fleet. Figures from the ARTEMIS project show that the effect of the load becomes proportionately greater for heavier classes of HGVs. In other words, the relative difference in fuel consumption between running an HGV completely empty or fully laden is greater for a large >33t HGV than it is for a small <7.5t HGV. From the analysis of the ARTEMIS data, it was possible to derive the figures in Table 29 showing the change in CO_2 emissions for a vehicle completely empty (0% load) or fully laden (100% load) on a weight basis compared with the emissions at half-load (50% load). The data show the effect of the load is symmetrical and largely independent of the HGVs Euro emission classification and type of drive cycle. So, for example, a >17t rigid HGV emits 18% more CO_2 per kilometre when fully laden and 18% less CO_2 per kilometre when empty relative to emissions at half-load.

6.4. The refrigerated/temperature-controlled HGVs included a 19.3% and 15.9% uplift which is applied to rigid and arctic refrigerated/temperature-controlled HGVs respectively. The refrigerated/temperature-controlled average factors have a 17.3% uplift applied. This is based on average data for different sizes of refrigerated HGV from (Tassou, S.A., et al., 2009). This accounts for the typical additional energy needed to power refrigeration equipment in such vehicles over similar non-refrigerated alternatives (AEA/Ricardo, 2011).

Table 29: Change in CO_2 emissions caused by +/- 50% change in load from the average loading factor of 50%

	Gross Vehicle Weight (GVW)	% change in CO2 emissions
Rigid	<7.5t	± 8%
	7.5-17t	± 12.5%
	>17 t	± 18%
Articulated	<33t	± 20%
	>33t	± 25%

Source: EU-ARTEMIS project

6.5. Using these loading factors, the CO_2 factors derived from the DfT survey's MPG data, each corresponding to different average states of HGV loading, were corrected to derive the 50% laden CO_2 factor shown for each class of HGV. These are shown in the final factors presented in the “Delivery vehicles” and “Freighting goods” worksheets of the 2025 GHG Conversion factors set.

6.6. The loading factors in Table 29 were then used to derive corresponding CO_2 factors for 0% and 100% loadings in the above sections. Because the effect of vehicle loading on CO_2 emissions is linear with load (according to the ARTEMIS data), then these factors can be linearly interpolated if a more precise figure on vehicle load is known. For example, an HGV running at 75% load would have a CO_2 factor halfway between the values for 50% and 100% laden factors.

6.7. It might be surprising to see that the CO_2 factor for a >17t rigid HGV is greater than for a >33t articulated HGV. However, these factors reflect the estimated MPG figures from DfT statistics that consistently show worse MPG fuel efficiency, on average, for large rigid HGVs than large articulated HGVs once the relative degree of loading is accounted for. This is likely to be a result of the usage pattern for different types of HGVs where large rigid HGVs may spend more time travelling at lower, more congested urban speeds, operating at lower fuel efficiency than articulated HGVs which spend more time travelling under higher speed, free-flowing traffic conditions on motorways where fuel efficiency is closer to optimum. Under the drive cycle conditions more typically experienced by large articulated HGVs, the CO_2 factors for large rigid HGVs may be lower than indicated in “Delivery vehicles” and “Freighting goods” worksheets of the 2025 GHG Conversion factors set. Thus, the factors in “Delivery vehicles” and “Freighting goods” worksheets, linked to the DfT statistics (DfT, 2017) on MPG (estimated by DfT from the survey data), reflect each HGV class’s typical usage pattern on the GB road network.

6.8. UK average factors for all rigid and articulated classes of HGVs are also provided in the “Delivery vehicles” and “Freighting goods” worksheets of the 2025 GHG Conversion factors set, if the user requires aggregate factors for these main classes of HGVs, perhaps in case the weight class of the HGV is not known. Again, these factors represent averages for the GB HGV fleet in 2022. These are derived directly from the mpg values for rigid and articulated HGVs in Table RFS0141 (DfT, 2017).

6.9. At a more aggregated level, factors for all HGVs are still representing the average MPG for all rigid and articulated HGV classes in Table RFS0141 (DfT, 2017). This factor should be used if the user has no knowledge of or requirement for different classes of HGVs and may be suitable for analysis of HGV CO_2 emissions in, for example, inter-modal freight transport comparisons.

6.10. The conversion factors included in the “Delivery vehicles” worksheet of the 2025 GHG Conversion factors set are provided in distance units to enable CO_2 emissions to be calculated from the distance travelled by the HGV in km multiplied by the appropriate conversion factor for the type of HGV and, if known, the extent of loading.

6.11. For comparison with other freight transport modes (e.g. road vs. rail), the user may require CO_2 factors in tonne km (tkm) units. The “Freighting goods” worksheet of the 2025 GHG Conversion factors set also provides such factors for each weight class of rigid and articulated HGVs, for all rigid and for all articulated, and aggregated for all HGVs. These are derived from the fleet average gCO_2 per vehicle km factors in the “Delivery vehicles” worksheet. The average tonnes of freight lifted figures are derived from the tkm and vehicle km (vkm) figures given for each class of HGVs in Tables RFS0113 and RFS0110, respectively (DfT, 2024a). Dividing the tkm by the vkm figures gives the average tonnes of freight lifted by each HGV class. The 2025 GHG Conversion factors include factors in tonne km (tkm) for all loads (0%, 50%, 100% and average).

6.12. A tkm is the distance travelled multiplied by the weight of freight carried by the HGV. So, for example, an HGV carrying 5 tonnes freight over 100 km has a tkm value of 500 tkm. The CO_2 emissions are calculated from these factors by multiplying the number of tkm the user has for the distance and weight of the goods being moved by the CO_2 conversion factor in the “Freighting goods” worksheet of the 2025 GHG Conversion factors for the relevant HGV class.

6.13. Conversion factors for CH_4 and N_2O for all HGV classes remain constant since the publication of 2021 GHG Conversion factors but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors are based on the conversion factors from the UK GHG Inventory 2021. CH_4 and N_2O emissions are assumed to scale relative to vehicle class/CO_2 emissions for HGVs. These factors are presented with an overall total factor in the “Delivery vehicles” and “Freighting goods” worksheets of the 2025 GHG Conversion factors set.

6.14. Emissions from the consumption of urea to control NO_x exhaust emissions (in SCR systems) in HGVs are included in the estimates for overall CO_2 emission factors. The method for this is the same as for buses, as described in the “Direct Emissions from Buses” section.

Direct Emissions from Vans/Light Goods Vehicles (LGVs)

6.15. Conversion factors for light good vehicles (LGVs, vans up to 3.5 tonnes gross vehicle weight - GVW), were calculated based on the conversion factors per vehicle-km in the earlier section on “Direct Emissions from Vans/Light Goods Vehicles (LGVs)”.

6.16. The typical / average capacities and average payloads that are used in the calculation of van conversion factors per tonne km are presented in Table 30. The average payload capacity values are based on the quantitative (registrations-weighted) assessment of the EEA and VCA van CO_2 monitoring databases for 2012-2022 registrations in the UK (EEA, 2021b), As previously mentioned new registrations for 2023 are obtained from the DfT table VEH0160_GB (DfT and DVLA, 2024), with typical / average capacities and average payloads for 2022 registrations based on the 2021 VCA database as used in the previous update. These databases provide information on the number of registrations for different vehicle makes and models with specifications including the unloaded (reference) mass of the vehicle, maximum permitted weight rating (i.e. Gross Vehicle Weight, GVW) and regulatory CO_2 emission factor.

Table 30: Typical van freight capacities and estimated average payload

Van fuel	Van size, Gross Vehicle Weight	Vkm % split	Av. Payload Capacity, tonnes	Av. Payload, tonnes
Petrol (Class I)	Up to 1.305 tonne	29.47%	0.38	0.14
Petrol (Class II)	1.305 to 1.740 tonne	65.41%	0.70	0.26
Petrol (Class III)	Over 1.740 tonne	5.11%	0.98	0.40
Petrol (average)	**Up to 3.5 tonne**	100.00%	0.62	0.25

Van fuel	Van size, Gross Vehicle Weight	Vkm % split	Av. Payload Capacity, tonnes	Av. Payload, tonnes
Diesel (Class I)	Up to 1.305 tonne	2.43%	0.49	0.18
Diesel (Class II)	1.305 to 1.740 tonne	23.46%	0.84	0.31
Diesel (Class III)	Over 1.740 tonne	74.11%	1.08	0.44
Diesel (average)	**Up to 3.5 tonne**	100.00%	1.01	0.40
LPG (average)	Up to 3.5 tonne	100.00%	1.00	0.40
CNG (average)	Up to 3.5 tonne	100.00%	1.00	0.40
Average	**Up to 3.5 tonne**	100.00%	1.00	0.40

6.17. The average load factors assumed for different vehicle types used to calculate the average payloads in Table 30 are summarised in Table 31, on the basis of DfT statistics from a survey of company owned vans. No new/more recent datasets were available for the average % loading of vans/LGVs for the 2025 update.

Table 31: Utilisation of vehicle capacity by company-owned LGVs: annual average 2003 – 2005 (proportion of total vehicle kilometres travelled)

Average van loading	Utilisation of vehicle volume capacity				
	0-25%	26-50%	51-75%	76-100%	Total
Mid-point for van loading ranges	12.5%	37.5%	62.5%	87.5%	
Proportion of vehicles in the loading range					
Up to 1.8 tonnes	45%	25%	18%	12%	**100%**
1.8 – 3.5 tonnes	36%	28%	21%	15%	**100%**
All LGVs	38%	27%	21%	14%	**100%**
Estimated weighted average % loading					
Up to 1.8 tonnes	-	-	-	-	**36.8%**
1.8 – 3.5 tonnes	-	-	-	-	**41.3%**
All LGVs	-	-	-	-	**40.3%**

Notes: Based on information from Table 24 from (Allen, J. and Browne, M., 2008)

6.18. Conversion factors for CH_4 and N_2O remain constant since the publication of 2021 GHG Conversion factors, but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors are based on the conversion factors from the UK GHG Inventory 2021. N_2O emissions are assumed to scale relative to vehicle class/CO_2 emissions for diesel vans.

6.19. Conversion factors per tonne km are calculated from the average load factors for the different weight classes in combination with the average freight capacities of the different vans in Table 30 and the conversion factors per vehicle-km in the “Delivery vehicles” and “Freighting goods” worksheets of the 2025 GHG Conversion factors set.

Direct Emissions from Rail Freight

6.20. Rail freight conversion factors remain constant since the publication of 2021 GHG Conversion factors, but have been updated from AR4 to AR5 GWP values.

6.21. The data used to update the rail freight conversion factors for the 2025 GHG Conversion factors set, was provided by the Office of the Rail Regulator's (ORR, 2021a). This factor is presented in "Freighting goods" worksheet of the 2025 GHG Conversion factors set.

6.22. The factor can be expected to vary with rail traffic route, speed and train weight. Freight trains are hauled by electric and diesel locomotives, but the vast majority of freight is carried by diesel rail and correspondingly CO_2 emissions from diesel rail freight are over 96% of the total CO_2 from rail freight for 2019-20 which is extrapolated to 2020-21 (ORR, 2021a).

6.23. Traffic-, route- and freight-specific factors are not currently available, though these would present a more appropriate means of comparing modes (e.g. for bulk aggregates, intermodal, other types of freight). The rail freight CO_2 factor will be reviewed and updated if data become available relevant to rail freight movement in the UK.

6.24. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors but have been updated to align with AR5 GWP values. These factors in the 2021 GHG Conversion factors were estimated from the corresponding emissions for diesel rail from the UK GHG Inventory 2021, proportional to the CO_2 emissions. The conversion factors were calculated based on the relative passenger km proportions of diesel and electric rail provided by DfT for 2006-7 in the absence of more suitable tonne km data for freight.

Indirect/WTT Emissions from Freight Land Transport

Vans and HGVs

6.25. Indirect/WTT conversion factors for Vans and HGVs include only emissions resulting from the fuel lifecycle (i.e. production and distribution of the relevant transport fuel). These indirect/WTT conversion factors were derived using simple ratios of the direct CO_2 conversion factors and the indirect/WTT conversion factors for the relevant fuels from the "Fuels" worksheet and applying the same ratios to the corresponding direct CO_2 conversion factors for vehicle types using these fuels.

Rail

6.26. Rail freight conversion factors remain constant since the publication of 2021 GHG Conversion factors, but have been updated from AR4 to AR5 GWP values.

6.27. The conversion factors for freight rail services are based on a mixture of emissions from diesel and electric rail. Indirect/WTT conversion factors were therefore calculated in a similar way to the other freight transport modes, except for combining indirect/WTT conversion factors for diesel and electricity into a weighted average for freight rail using relative CO_2 emissions from traction energy for diesel and electric freight rail provided from ORR in “Table 2.100 Estimates of passenger and freight energy consumption and CO_2e emissions” (ORR, 2021a).

7. Sea Transport Emission Factors

Section summary

7.1. This section contains Scope 3 factors only, relating to direct emissions from transport by sea, and WTT emissions for business travel by sea, and for freighting goods by sea. The business travel factors should be used for passenger ferries used for business trips. The WTT factors relate to emissions from the upstream extraction, refining and transport of fuels before they are used to power the ships.

7.2. Sea Transport factors remain constant since the publication of 2021 GHG Conversion factors but have been updated from AR4 to AR5 GWP values in the 2023 update.

7.3. Table 32 shows where the related worksheets to the sea transport conversion factors are available in the online spreadsheets of the UK GHG Conversion factors set.

Table 32: Related worksheets to sea transport emission factors

Worksheet name	Full set	Condensed set
Business travel – sea	Y	Y
WTT – business travel – sea	Y	N
Freighting goods*	Y	Y
WTT – delivery vehicles & freight*	Y	N

Note: * sea tankers and cargo ships only

Summary of changes since the previous update

7.4. There were no major methodological changes in the 2025 update.

Direct Emissions from RoPax Ferry Passenger Transport and freight

7.5. Direct conversion factors from RoPax (roll on/roll off a passenger) passenger ferries and ferry freight transport is based on information from the Best Foot Forward (BFF) work for the Passenger Shipping Association (PSA) (BFF, 2007). No new methodology or updated dataset has been identified for the 2025 GHG Conversion factors set.

7.6. The BFF study analysed data for mixed passenger and vehicle ferries (RoPax ferries) on UK routes supplied by PSA members. Data provided by the PSA operators included information by operating route on the route/total distance, total passenger numbers, total car numbers, total freight units and total fuel consumption.

7.7. From the information provided by the operators, figures for passenger-km, tonne-km and CO_2 emissions were calculated. CO_2 emissions from ferry fuels were allocated between passengers and freight on the basis of tonnages transported, taking into account freight, vehicles and passengers. Some of the assumptions included in the analysis are presented in the following table.

Table 33: Assumptions used in the calculation of ferry emission factors

Assumption	Weight, tonnes	Source
Average passenger car weight	1.250	(MCA, 2025)
Average weight of passenger + luggage, total	0.100	(MCA, 2025)
Average Freight Unit*, total	22.173	(BFF, 2007)[27]
Average Freight Load (per freight unit)*, tonnes	13.624	(DfT, 2006)

Notes: * Freight unit includes weight of the vehicle/container as well as the weight of the actual freight load

7.8. CO_2 emissions are allocated to passengers based on the weight of passengers + luggage + cars relative to the total weight of freight including freight vehicles/containers. For the data supplied by the 11 (out of 17) PSA operators this equated to just under 12% of the total emissions of the ferry operations. The emission factor for passengers was calculated from this figure and the total number of passenger-km, and is presented in the “Business travel – sea” worksheet of the 2025 GHG Conversion factors set. A further split has been provided between foot-only passengers and passengers with cars in the 2025 GHG Conversion factors set, again on a weight allocation basis. Passengers with cars' passenger-km factors should be used on a single-person basis, not account for the whole vehicle.

7.9. CO_2 emissions are allocated to freight based on the weight of freight (including freight vehicles/containers) relative to the total weight of passengers + luggage + cars. For the data supplied by the 11 (out of 17) PSA operators, this equated to just over 88% of the total emissions of the ferry operations. The emission factor for freight was calculated from this figure and the total number of tonne km (excluding the weight of the freight vehicle/container) and is presented in “Freighting goods” worksheet of the 2025 GHG Conversion factors set.

7.10. It is important to note that this conversion factor is relevant only for ferries carrying passengers and freight and that conversion factors for passenger only ferries are likely to be significantly higher. No suitable dataset has yet been identified to enable the production of a ferry emission factor for passenger-only services (which were excluded from the BFF (2007) work).

[27] This is based on a survey of actual freight weights at 6 ferry ports. Where operator-specific freight weights were available, these were used instead of the average figure.

7.11. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors but have been updated to align with AR5 GWP values. These conversion factors had been estimated from the corresponding emissions for shipping from the 2021 update of the UK GHG Inventory (Ricardo Energy & Environment, 2021), proportional to the CO_2 emissions.

Direct Emissions from Other Marine Freight Transport

7.12. CO_2 conversion factors for the other representative ships (apart from RoPax ferries discussed above) are based on information- estimates of CO_2 efficiency for cargo ships, from Table 9-1 of the (IMO, 2009) report on GHG emissions from ships. The figures in the “Freighting goods” worksheet of the 2025 GHG Conversion factors set represent international average data (i.e. including vessel characteristics and typical loading factors), as UK-specific datasets are not available.

7.13. CH_4 and N_2O conversion factors remain constant since the publication of 2021 GHG Conversion factors but have been updated from AR4 to AR5 GWP values. These conversion factors had been estimated from the corresponding emissions for shipping from the 2021 update of UK GHG Inventory (Ricardo Energy & Environment, 2021), proportional to the CO_2 emissions.

Indirect/WTT Emissions from Sea Transport

7.14. Indirect/WTT emissions factors for ferries and ships include only emissions resulting from the fuel lifecycle (i.e. production and distribution of the relevant transport fuel). These indirect/WTT conversion factors were derived using simple ratios of the direct CO_2 conversion factors and the indirect/WTT conversion factors for the relevant fuels and the corresponding direct CO_2 conversion factors for ferries and ships using these fuels.

8. Air Transport Emission Factors

Section summary

8.1. This section contains Scope 3 factors only, related to direct emissions from and WTT emissions for business travel and freight transport by air. Air transport conversion factors should be used to report Scope 3 emissions for individuals flying for work purposes, and the related WTT factors account for the upstream emissions associated with the extraction, refining and transport of the aviation fuels prior to take-off. For freighting goods, conversion factors are provided per tonne.km of goods transported.

8.2. Air Transport conversion factors have been updated in the 2025 Conversion factors. CH_4, N_2O, and WTT Air Transport factors have been constant since the publication of 2023 GHG Conversion factors (aligned with AR5 GWPs values).

8.3. Table 34 shows where the related worksheets to the air transport conversion factors are available in the online spreadsheets of the UK GHG Conversion factors set.

Table 34: Related worksheets to air transport emission factors

Worksheet name	Full set	Condensed set
Business travel – air	Y	Y
WTT – business travel – air	Y	N
Freighting goods*	Y	Y
WTT – delivery vehicles & freight*	Y	N

Notes: * freight flights only

Summary of changes since the previous update

8.4. There are major changes to the air transport factors in the 2025 update, principally due to the impact of post-covid recovery on load factors. In the previous 2023 update of air transport factors (based on 2021 data), load factors were significantly reduced due to the impacts of the COVID-19 pandemic. Other changes are result from the improvement to use new publicly available CAA data (described below) and revisions to the EUROCONTROL small emitters tool.

8.5. There was an improvement in the 2025 update to use new publicly available data from CAA (Civil Aviation Authority) to replace the old 2012 data sets from CAA. Prior to 2025 update, confidential 2012 CAA data were used to provide detailed breakdowns of flight activity — including number of flights, flight km, seat km, number of passengers, total tonnes km available (passengers plus cargo), freight tonnes km used, mail tonnes km used, passenger tonnes km used, and total cargo uplifted, broken down by Aircraft type, and Sector (Domestic, EEA, and other international). This information was used to (i) apportion flights, flight km, and tonne km between domestic, short haul, and long haul, (ii) provide cargo capacity, and load factors, and (iii) apportion CO_2 emissions from passenger flights between passengers and freight. However, the 2012 data were provided confidentially and there is no up- to-date dataset which is in the same format. The 2025 update has therefore introduced an improvement by replacing the older 2012 data sets from CAA with new publicly available data from CAA, to enhance transparency and enable regular updates with the up-to-date fleet data. As a result of this improvement, there are changes, particularly affecting freight flights factors.

Passenger Air Transport Direct CO_2 Emission Factors

8.6. Conversion factors for non-UK international flights were calculated in a similar way to the main UK flight emission factors, using DfT data on flights between different regions by aircraft type, and conversion factors calculated using the EUROCONTROL small emitter's tool.

8.7. The 2025 update of the average factors (presented at the end of this section) uses the EUROCONTROL small emitters tool to calculate the CO_2 emissions factors resulting from fuel burnt over average flights for different aircraft. This data source has been selected because:

a) The tool is based on a methodology designed to estimate the fuel burnt for an entire flight, it is updated on a regular basis in order to improve when possible its accuracy, and has been validated using actual fuel consumption data from airlines operating in Europe.
b) The tool covers a wide range of aircraft, including many newer (and more efficient) aircraft increasingly used in flights to/from the UK, and also variants in aircraft families.
c) The tool is approved for use for flights falling under the EU ETS via the Commission Regulation (EU) No. 606/2010.

8.8. A full summary of the representative aircraft selection and the main assumptions influencing the emission factor calculation are presented in Table 35. Key features of the calculation methodology, data and assumptions include:

a) A wide variety of representative aircraft have been used to calculate conversion factors for domestic, short- and long-haul flights;
b) Average seating capacities, load factors and proportions of passenger km by the different aircraft types (subsequently aggregated to overall averages for domestic, short- and long-haul flights) have all been calculated from detailed UK Civil Aviation Authority (CAA, 2023) statistics for UK registered airlines for the year 2023 (the most recent complete dataset available at the time of calculation), split by aircraft and route type (Domestic, European Economic Area, other International) and airline fleet data (also from UK Civil Aviation Authority (CAA, 2023);
c) Freight transported on passenger services has also been accounted for (with the approach taken summarised in the following section). Accounting for freight makes a significant difference to long-haul factors.

Table 35: Assumptions used in the calculation of revised average CO_2 conversion factors for passenger flights for 2025

	Av. No. Seats	Av. Load Factor	Proportion of passenger km	Emissions Factor, $kgCO_2/vkm$	Av. flight length, km
Domestic Flights					
AIRBUS A320neo	184	75%	13%	13.3	453
AIRBUS A321neo	222	73%	2%	14.8	482
AIRBUS A319	153	79%	29%	15.0	485
AIRBUS A320-100/200	182	75%	33%	16.4	460
AIRBUS A321	217	72%	1%	18.0	468
ATR-42-500	49	58%	1%	5.2	369
ATR72 200/500/600	71	67%	6%	5.6	310
BOEING 737 MAX 8	197	85%	0%	12.6	489
BOEING 737-800	189	78%	5%	15.3	432
BOMBARDIER DASH 8 Q400	78	45%	0%	7.3	370
EMBRAER ERJ145	49	67%	4%	7.4	488
EMBRAER ERJ190	98	74%	5%	11.6	547
EMBRAER ERJ195	122	75%	0%	15.5	274
SAAB FAIRCHILD 340	35	66%	0%	4.4	241
Average	***157***	***75%***	***100%* (total)***	***12.2***	***434***
Short-haul Flights					
AIRBUS A320neo	183	79%	10%	9.2	1540
AIRBUS A321neo	226	82%	9%	10.3	1986
AIRBUS A319	152	83%	6%	11.5	1076
AIRBUS A320-100/200	182	81%	20%	11.6	1379
AIRBUS A321	221	82%	5%	13.0	1692
AIRBUS A330-200	323	93%	0%	21.9	2425
AIRBUS A330-300	312	78%	1%	22.7	2218
AIRBUS A350-900	326	75%	0%	22.9	1674
ATR72 200/500/600	72	76%	0%	5.5	329
BOEING 737 MAX 8	199	85%	10%	9.3	1692
BOEING 737-300	148	89%	0%	11.6	1562
BOEING 737-800	189	86%	35%	11.0	1645
BOEING 757-200	235	90%	1%	14.3	2397
BOEING 767-300ER/F	328	90%	0%	19.5	2585
BOEING 777-300ER	358	77%	0%	29.6	2860
BOEING 787-900 DREAMLINER	323	76%	0%	20.0	2646

	Av. No. Seats	Av. Load Factor	Proportion of passenger km	Emissions Factor, $kgCO_2/vkm$	Av. flight length, km
AIRBUS A220-300	134	71%	0%	10.2	738
AIRBUS A220-300	147	75%	0%	10.4	791
EMBRAER ERJ190	100	73%	1%	10.5	758
Average	***193***	***83%***	***100%* (total)***	***11.0***	***1,484***
Long-haul Flights					
AIRBUS A320neo	184	77%	0%	8.6	3650
AIRBUS A321neo	170	79%	1%	10.0	4865
AIRBUS A330-200	254	69%	1%	21.0	6464
AIRBUS A330-300	285	75%	4%	22.1	6609
AIRBUS A330-900	272	73%	2%	19.7	6852
AIRBUS A350-900	299	82%	4%	21.4	8634
AIRBUS A350-1000	344	83%	8%	24.2	7342
AIRBUS A380-800	505	82%	14%	46.6	6701
BOEING 737 MAX 8	184	90%	0%	8.9	4473
BOEING 757-200	175	86%	0%	14.1	5455
BOEING 767-300ER/F	187	76%	2%	18.9	5704
BOEING 767-400	246	78%	1%	20.7	6095
BOEING 777-200	274	81%	14%	24.8	6718
BOEING 777-300ER	321	82%	18%	28.8	7178
BOEING 787-800 DREAMLINER	248	86%	9%	18.2	6758
BOEING 787-900 DREAMLINER	273	82%	19%	18.8	7228
BOEING 787-1000 DREAMLINER	286	79%	2%	21.1	5867
Average	***316***	***81%***	***100%* (total)***	***24.0***	***6,799***

Notes: Figures on seats, load factors, % tkm and av. flight length have been calculated from 2023 CAA statistics for UK registered airlines for the different aircraft types. Figures of $kgCO_2/vkm$ were calculated using the average flight lengths in the EUROCONTROL small emitters tool. * 100% denotes the pkm share of the aircraft included in the assessment - as listed in the table. The aircraft listed in the table above accounts for 100% of domestic pkm, 100% of short-haul pkm and 100% of long-haul pkm. The averages presented have different weightings applied. The average number of seats and average load factors are weighted by pkm, whereas the average emission factor is weighted by vkm and the average flight length is weighted by the number of flights. They are provided for illustration only.

Allocating flights into short- and long-haul:

8.9. Domestic flights are those that start and end in the United Kingdom (including the Isle of Man and the Channel Islands, but excluding Gibraltar), which are relatively simple to categorise. However, allocating flights into short- and long-haul is more complicated. In earlier versions of the GHG Conversion factors, it was suggested at a crude level to assign all flights <3700km to short haul and all >3,700km to long-haul (on the basis of the maximum range of a Boeing 737). However, this approach was relatively simplistic, difficult to apply without detailed flight distance calculations, and was not completely consistent with CAA statistical dataset used to define the emission factors.

8.10. The current preferred definition, which aligns with the CAA statistical dataset, is to assume that all fights between the UK and Europe (excluding Moldova and Ukraine, but including the Channel Islands, Gibraltar, Greenland and Turkey) and between the UK and North Africa (Algeria, Egypt, Libya, Morocco and Tunisia) are also short-haul. Flights between the UK and other destinations (North and South America, Asia (including Russia, but excluding Turkey), most of Africa, Australasia, Moldova and Ukraine should be counted as long-haul. Some examples of have been provided in the following Table 36.

Table 36: Illustrative short- and long- haul flight distances from the UK

Area	Destination Airport	Distance, km
Domestic		
Average (CAA statistics)		**434**
Short-haul		
Europe	Amsterdam, Netherlands	400
Europe	Prague (Ruzyne), Czech Rep	1,000
Europe	Malaga, Spain	1,700
Europe	Athens, Greece	2,400
North Africa	Abu Simbel/Sharm El Sheikh, Egypt	3,300
Average (CAA statistics)		**1,484**
Long-haul		
Southern Africa	Johannesburg/Pretoria, South Africa	9,000
Middle East	Dubai, UAE	5,500
North America	New York (JFK), USA	5,600
North America	Los Angeles California, USA	8,900
South America	Sao Paulo, Brazil	9,400

Area	Destination Airport	Distance, km
Indian sub-continent	Bombay/Mumbai, India	7,200
Far East	Hong Kong	9,700
Australasia	Sydney, Australia	17,000
Average (CAA statistics)		**6,799**

Note: Distances based on International Passenger Survey (Office for National Statistics) calculations using airport geographic information. Average distances calculated from CAA statistics for all flights to/from the UK in 2023

8.11. Aviation factors are also included for international flights between non-UK destinations. This relatively high-level analysis of Innovata data on intercontinental flights provided by DfT's aviation team allows users to choose a different factor for passenger air travel if flying between countries outside of the UK. All factors presented are for direct (non-stop) flights only. This analysis was only possible for passenger air travel and so international freight factors are assumed to be equal to the current UK long haul air freight factors[28].

Taking Account of Freight

8.12. Freight, including mail, are transported by two types of aircraft – dedicated cargo aircraft which carry freight only, and passenger aircraft which carry both passengers and their luggage, as well as freight. The CAA data show that almost all freight carried by passenger aircraft is done on scheduled long-haul flights. In fact, the quantity of freight carried on scheduled long-haul passenger flights is more than 4 times higher than the quantity of freight carried on scheduled long-haul cargo services (however this is not the case when comparing individual flights).

8.13. The CAA data provides a split of tonne km for freight and passengers (plus luggage) by airline for both passenger and cargo services. This data may be used as a basis for an allocation methodology. There are essentially three options, with the resulting conversion factors presented in Table 37:

a. **No Freight Weighting:** Assume all the CO_2 is allocated to passengers on these services.
b. **Freight Weighting Option 1:** Use the CAA tonne km (tkm) data directly to apportion the CO_2 **between passengers and freight**. However, in this case, the derived conversion factors for freight are significantly higher than those derived for dedicated cargo services using similar aircraft.
c. **Freight Weighting Option 2:** Use the CAA tkm data modified to treat freight on a more equivalent/consistent basis to dedicated cargo services. This accounts for the additional weight of equipment specific to passenger services (e.g. seats, galleys, etc.) in the calculations.

[28] Please note - The international factors included are an average of short and long-haul flights which explains the difference between the UK factors and the international ones.

Table 37: CO_2 conversion factors for alternative freight allocation options for passenger flights based on 2025 GHG Conversion factors

Freight Weighting:	None		Option 1: Direct		Option 2: Equivalent	
Mode	Passenger tkm % of total	gCO_2 /pkm	Passenger tkm % of total	gCO_2 /pkm	Passenger tkm % of total	gCO_2 /pkm
Domestic flights	100.00%	124.1	99.97%	124.0	99.97%	124.0
Short-haul flights	100.00%	69.5	99.46%	69.1	99.46%	69.1
Long-haul flights	100.00%	99.6	83.04%	82.5	83.04%	82.5

8.14. The basis of the freight weighting **Option 2** is to take account of the supplementary equipment (such as seating, galley) and other weight for passenger aircraft compared to dedicated cargo aircraft in the allocation. In comparing the freight capacities of the cargo configuration compared to passenger configurations, we may assume that the difference represents the tonne capacity for passenger transport. This includes the weight of passengers and their luggage (around 100 kg per passenger according to IATA), plus the additional weight of seating, the galley, and other airframe adjustments necessary for passenger service operations. The derived weight per passenger seat used in the calculations for the 2025 GHG Conversion factors were calculated for the specific aircraft used and are on average over three times (3.09) the weight per passenger and their luggage alone. In the **Option 2** methodology the derived ratio for different aircraft types were used to upscale the CAA passenger tonne km data, increasing this as a percentage of the total tonne km – as shown in Table 37.

8.15. It does not appear that there is a distinction made (other than in purely practical size/bulk terms) in the provision of air freight transport services in terms of whether something is transported by dedicated cargo service or on a passenger service. The related calculation of freight conversion factors (discussed in a later section) leads to very similar conversion factors for both passenger service freight and dedicated cargo services for domestic and short-haul flights. This is also the case for long-haul flights under freight weighting **Option 2**, whereas under **Option 1** the passenger service factors are substantially higher than those calculated for dedicated cargo services. It therefore seems preferable to treat freight on an equivalent basis by utilising freight weighting **Option 2**.

8.16. **Option 2** is the preferred methodology to allocate emissions between passengers and freight, **Option 1** is included for information only.

8.17. Validation checks using the derived conversion factors calculated using the EUROCONTROL small emitters tool and CAA flights data have shown a very close comparison in derived CO_2 emissions with those from the UK GHG Inventory (which is scaled using actual fuel supplied) (Ricardo, 2025).

8.18. The final average conversion factors for aviation are presented in Table 38. The figures in Table 38 **DO NOT** include the 8% uplift for Great Circle distance NOR the uplift to account for additional impacts of radiative forcing which are applied to the conversion factors provided in the 2025 GHG Conversion Factor set.

Table 38: Final average CO_2 conversion factors for passenger flights for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Mode	Factors for 2025	
	Av. Load Factor%	gCO_2 /pkm
Domestic flights	74.9%	124.0
Short-haul flights	83.3%	69.1
Long-haul flights	81.3%	82.5

Notes: Average load factors based on data provided by DfT that contains detailed analysis of CAA statistics for the year 2023

Taking Account of Seating Class Factors

8.19. The efficiency of aviation per passenger km is influenced not only by the technical performance of the aircraft fleet, but also by the occupancy/load factor of the flight. Different airlines provide different seating configurations that change the total number of seats available on similar aircraft. Premium priced seating, such as in First and Business class, takes up considerably more room in the aircraft than economy seating and therefore reduces the total number of passengers that can be carried. This in turn raises the average CO_2 emissions per passenger km.

8.20. There is no agreed data/methodology for establishing suitable scaling factors representative of average flights. However, in 2008 a review was carried out of the seating configurations from a selection of 16 major airlines and average seating configuration information from Boeing and Airbus websites. This evaluation was used to form a basis for the seating class based conversion factors provided in Table 39, together with additional information obtained either directly from airline websites or from other specialist websites that had already collated such information for most of the major airlines.

8.21. For long-haul flights, the relative space taken up by premium seats can vary by a significant degree between airlines and aircraft types. The variation is at its most extreme for First class seats, which can account for from 3 to over 6 times[29] the space taken up by the basic economy seating. Table 39 shows the seating class-based emission factors, together with the assumptions made in their calculation. An indication is also provided of the typical proportion of the total seats that the different classes represent in short- and long-haul flights. The effect of the scaling is to lower the economy seating emission factor in relation to the average, and increase the business and first class factors.

8.22. For domestic flights, the space taken up by premium seats is not significantly more than that taken up by the basic economy seating. It was therefore deemed unnecessary to provide further breakdown by seating class.

8.23. The relative share in the number of seats by class for short-haul and long-haul flights was updated/revised in 2015 using data provided by DfT's aviation team,

[29] For the first-class sleeper seats/beds frequently used in long-haul flights.

following checks conducted by them on the validity of the current assumptions based on more recent data.

Table 39: CO_2 conversion factors by seating class for passenger flights for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Flight type	Cabin Seating Class	Av. Load Factor %	gCO_2 /pkm	Number of economy seats	% of average gCO_2/pkm	% Total seats
Domestic	**Weighted average**	**74.9%**	**124.0**	**1.00**	**100.0%**	**100.0%**
Short-haul	**Weighted average**	**83.3%**	**69.1**	**1.02**	**100.0%**	**100.0%**
	Economy class	83.3%	68.0	1.00	98.4%	96.7%
	First/Business class	83.3%	102.0	1.50	147.5%	3.3%
Long-haul	**Weighted average**	**81.3%**	**82.5**	**1.31**	**100.0%**	**100.0%**
	Economy class	81.3%	63.2	1.00	76.6%	83.0%
	Economy+ class	81.3%	101.1	1.60	122.5%	3.0%
	Business class	81.3%	183.3	2.90	222.1%	11.9%
	First class	81.3%	252.8	4.00	306.3%	2.0%

Notes: Average load factors based on data provided by DfT that contains detailed analysis of CAA statistics for the year 2021

Freight Air Transport Direct CO_2 Emission Factors

8.24. Freight Air transport factors have been updated in the 2025 Conversion Factors .

8.25. Air Freight, including mail, are transported by two types of aircraft – dedicated cargo aircraft which carry freight only, and passenger aircraft which carry both passengers and their luggage, as well as freight.

8.26. Data on freight movements by type of service are available from the Civil Aviation Authority (CAA, 2023). These data show that almost all freight carried by passenger aircraft is done on scheduled long-haul flights and accounts approximately for 100% of all long-haul air freight transport. How this freight carried on long-haul passenger services is treated has a significant effect on the average emission factor for all freight services.

8.27. The next section describes the calculation of conversion factors for freight carried by cargo aircraft **only** and then the following sections examine the impact of freight carried by passenger services and the overall average for all air freight services.

Conversion factors for Dedicated Air Cargo Services

8.28. Table 40 presents the average conversion factors for dedicated air cargo. As with the passenger aircraft methodology, the factors presented here do not include the distance or radiative forcing uplifts applied to the conversion factors provided in the 2025 GHG Conversion Factor data tables.

Table 40: Revised average CO_2 conversion factors for dedicated cargo flights for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Mode	Factors for 2025	
	Av. Load Factor%	$kgCO_2$/tkm
Domestic flights	32.2%	2.5
Short-haul flights	53.4%	0.7
Long-haul flights	54.5%	0.6

Note: Average load factors based on Annual UK Airlines Statistics by Aircraft Type – CAA 2023

8.29. The updated factors have been calculated in the same basic methodology as for the passenger flights, using the EUROCONTROL small emitters tool (EUROCONTROL, 2024). A full summary of the representative aircraft selection and the main assumptions influencing the emission factor calculation are presented in Table 41. The key features of the calculation methodology, data and assumptions for the GHG Conversion factors include:

a) A wide variety of representative aircraft have been used to calculate conversion factors for domestic, short- and long-haul flights;
b) Average freight capacities, load factors and proportions of tonne km by the different airlines/aircraft types have been calculated from CAA (Civil Aviation Authority) statistics for UK registered airlines for the year 2023 (the latest available complete dataset) (CAA, 2023).

Table 41: Assumptions used in the calculation of average CO_2 conversion factors for dedicated cargo flights for the 2025 GHG Conversion factors

	Average Cargo Capacity, tonnes	Av. Load Factor	Proportion of tonne km	EF, $kgCO_2$ /vkm	Av. flight length, km
Domestic Flights					
AIRBUS A319	0.0	0%	0.0%	0.00	0
AIRBUS A320-100/200	0.0	0%	0.0%	0.00	0
AIRBUS A320neo	0.0	0%	0.0%	0.00	0
AIRBUS A321	22.0	28%	0.0%	17.76	486
AIRBUS A321neo	0.0	0%	0.0%	0.00	0
AIRBUS A330-300	39.7	28%	12.8%	24.02	1303
AIRBUS A340-600	0.0	0%	0.0%	0.00	0
AIRBUS A350-1000	0.0	0%	0.0%	0.00	0
AIRBUS A380-800	0.0	0%	0.0%	0.00	0

	Average Cargo Capacity, tonnes	Av. Load Factor	Proportion of tonne km	EF, $kgCO_2$ /vkm	Av. flight length, km
ATR72 200/500/600	7.0	29%	10.3%	5.88	263
BEECH 200	1.7	10%	0.0%	2.04	421
BOEING 737-300	17.5	31%	9.4%	15.81	453
BOEING 737-400	18.9	31%	28.1%	16.32	408
BOEING 737-800	22.6	32%	13.7%	14.72	489
BOEING 747-400F	0.0	0%	0.0%	0.00	0
BOEING 757-200	14.4	37%	0.6%	55.04	110
BOEING 767-300ER/F	29.9	37%	9.6%	29.85	379
BOEING 777-200	0.0	0%	0.0%	0.00	0
BOEING 777-300ER	0.0	0%	0.0%	0.00	0
BOEING 777-F	57.4	37%	15.3%	35.88	695
BOEING 787-1000 DREAMLINER	0.0	0%	0.0%	0.00	0
BOEING 787-900 DREAMLINER	0.0	0%	0.0%	0.00	0
CESSNA F406	1.4	10%	0.0%	1.56	475
Average	***27.7***	***32%***	***100%***	***15.21***	***372***
Short-haul Flights					
AIRBUS A319	0.0	0%	0.0%	0.00	0
AIRBUS A320-100/200	16.0	77%	0.0%	0.00	0
AIRBUS A320neo	16.1	77%	0.0%	0.00	0
AIRBUS A321	35.4	74%	0.0%	15.82	687
AIRBUS A321neo	20.5	77%	0.0%	0.00	0
AIRBUS A330-300	63.5	74%	0.5%	22.84	1837
AIRBUS A340-600	70.0	51%	0.0%	0.00	0
AIRBUS A350-1000	54.2	77%	0.0%	0.00	0
AIRBUS A380-800	67.6	77%	0.0%	0.00	0
ATR72 200/500/600	8.8	31%	0.0%	0.00	0
BEECH 200	1.7	15%	0.0%	0.00	0
BOEING 737-300	21.5	33%	0.0%	0.00	0
BOEING 737-400	24.2	51%	0.0%	35.04	96

	Average Cargo Capacity, tonnes	Av. Load Factor	Proportion of tonne km	EF, $kgCO_2$ /vkm	Av. flight length, km
BOEING 737-800	25.6	25%	0.0%	0.00	0
BOEING 747-400F	134.5	73%	0.0%	0.00	0
BOEING 757-200	25.8	53%	2.5%	32.20	237
BOEING 767-300ER/F	53.7	53%	37.4%	23.08	813
BOEING 777-200	57.5	77%	0.0%	0.00	0
BOEING 777-300ER	81.8	77%	0.0%	0.00	0
BOEING 777-F	103.1	53%	59.6%	30.27	1492
BOEING 787-1000 DREAMLINER	46.1	77%	0.0%	0.00	0
BOEING 787-900 DREAMLINER	42.7	77%	0.0%	0.00	0
CESSNA F406	1.4	15%	0.0%	0.00	0
Average	***82.5***	***53%***	***100%***	***26.74***	***830***
Long-haul Flights					
AIRBUS A319	0.0	0%	0.0%	0.00	0
AIRBUS A320-100/200	16.0	77%	0.0%	12.55	1001
AIRBUS A320neo	16.1	77%	0.0%	10.19	1001
AIRBUS A321	35.4	74%	0.0%	16.61	590
AIRBUS A321neo	20.5	77%	0.0%	10.10	3504
AIRBUS A330-300	63.5	74%	2.9%	20.46	13542
AIRBUS A340-600	70.0	51%	5.4%	31.31	8383
AIRBUS A350-1000	54.2	77%	0.1%	24.50	4505
AIRBUS A380-800	67.6	77%	0.1%	46.96	8509
ATR72 200/500/600	8.8	31%	0.0%	5.17	403
BEECH 200	1.7	15%	0.0%	1.75	1151
BOEING 737-300	21.5	33%	0.0%	13.87	646
BOEING 737-400	24.2	51%	0.1%	14.11	664
BOEING 737-800	25.6	25%	0.3%	11.37	1373
BOEING 747-400F	134.5	73%	3.6%	39.96	5226
BOEING 757-200	25.8	53%	2.2%	16.71	1074
BOEING 767-300ER/F	53.7	53%	32.8%	19.41	3686

	Average Cargo Capacity, tonnes	Av. Load Factor	Proportion of tonne km	EF, $kgCO_2$ /vkm	Av. flight length, km
BOEING 777-200	57.5	77%	0.1%	25.20	3822
BOEING 777-300ER	81.8	77%	0.0%	28.88	6007
BOEING 777-F	103.1	53%	52.3%	29.95	6766
BOEING 787-1000 DREAMLINER	46.1	77%	0.0%	21.70	4004
BOEING 787-900 DREAMLINER	42.7	77%	0.0%	19.28	4338
CESSNA F406	1.4	15%	0.0%	1.37	1300
Average	***82.9***	***54%***	***100%***	***28.09***	***3,700***

Note: Figures on cargo, load factors, % tkm and av. flight length have been calculated from CAA statistics for UK registered airlines for different aircraft in the year 2023. Figures of $kgCO_2$/vkm were calculated using the average flight lengths in the EUROCONTROL small emitters tool (EUROCONTROL, 2024).

Conversion factors for Freight on Passenger Services

8.30. The CAA data provides a similar breakdown for freight on passenger services as it does for cargo services. As previously discussed, the statistics give tonne-km data for passengers and for freight. This information has been used in combination with the assumptions for the earlier calculation of passenger conversion factors to calculate the respective total emission factor for freight carried on passenger services. These conversion factors are presented in Table 42 with the two different allocation options for long-haul services. The factors presented here do not include the distance or radiative forcing uplifts applied to the conversion factors provided in the 2025 GHG Conversion Factor set (discussed later).

Table 42: Air freight CO_2 conversion factors for alternative freight allocation options for passenger flights for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Freight Weighting: Mode	% Total Freight tkm		Option 1: Direct		Option 2: Equivalent	
	Passenger Services (PS)	Cargo Services	PS Freight tkm, % total	Overall $kgCO_2$ /tkm	PS Freight tkm, % total	Overall $kgCO_2$ /tkm
Domestic flights	0.9%	99.1%	0.0%	2.5	0.0%	2.5
Short-haul flights	0.2%	99.8%	0.5%	0.7	0.5%	0.7
Long-haul flights	68.0%	32.0%	17.0%	0.8	17.0%	0.5

8.31. CAA statistics include excess passenger baggage in the ‘freight’ category, which would under **Option 1** result in a degree of under-allocation to passengers. **Option 2** therefore appears to provide the more reasonable means of allocation.

8.32. **Option 2** has been selected as the preferred methodology for freight allocation and is included in all of the presented conversion factors for 2025.

Average Conversion factors for All Air Freight Services

8.33. Table 43 presents the final average air freight conversion factors for all air freight for the 2025 GHG Conversion factors. The conversion factors have been calculated from the individual factors for freight carried on passenger and dedicated freight services, weighted according to their respective proportion of the total air freight tonne km. The factors presented here do not include the distance or radiative forcing uplifts applied to the conversion factors provided in the 2025 GHG Conversion Factor set (discussed later).

Table 43: Final average CO_2 conversion factors for all air freight for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Mode	% Total Air Freight tkm		All Air Freight kgCO_2/tkm
	Passenger Services	Cargo Services	
Domestic flights	0.9%	99.1%	2.5
Short-haul flights	0.2%	99.8%	0.7
Long-haul flights	68.0%	32.0%	0.5

Note: % Total Air Freight tkm based on CAA statistics for 2023 (T0.1.6 All Services)

Air Transport Direct Conversion factors for CH_4 and N_2O

Emissions of CH_4

8.34. Total emissions of CO_2, CH_4 and N_2O are calculated in detail and reported at an aggregate level for aviation as a whole in the UK GHG inventory. The relative proportions of total CO_2 and CH_4 emissions from the UK GHG inventory for 2021 (Ricardo, 2025) (see Table 44) were used to calculate the specific CH_4 conversion factors per passenger km or tonne-km relative to the corresponding CO_2 emission factors. The resulting air transport conversion factors for the 2025 GHG Conversion factors are presented in Table 45 for passengers and Table 46 for freight.

Table 44: Total emissions of CO_2, CH_4 and N_2O for domestic and international aircraft from the UK GHG inventory for 2023

	CO_2		CH_4		N_2O	
	Mt CO_2e	% Total CO_2e	Mt CO_2e	% Total CO_2e	Mt CO_2e	% Total CO_2e
Aircraft - domestic	1.31	99.03%	0.0017	0.12%	0.011	0.84%

	CO_2		CH_4		N_2O	
	Mt CO_2e	% Total CO_2e	Mt CO_2e	% Total CO_2e	Mt CO_2e	% Total CO_2e
Aircraft - international	32.77	99.15%	0.0024	0.01%	0.279	0.84%

Emissions of N_2O

8.35. Similar to those for CH_4, conversion factors for N_2O per passenger-km or tonne-km were calculated on the basis of the relative proportions of total CO_2 and N_2O emissions from the UK GHG inventory for 2023 (Ricardo, 2025) (see Table 44), and the corresponding CO_2 emission factors. The resulting air transport conversion factors for the 2025 GHG Conversion factors are presented in Table 45 for passengers and Table 46 for freight. The factors presented here do not include the distance or radiative forcing uplifts applied to the conversion factors provided in the 2025 GHG Conversion Factor set (discussed later).

Table 45: Final average CO_2, CH_4 and N_2O conversion factors for all air passenger transport for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Air Passenger Mode	Seating Class	CO_2 gCO_2/pkm	CH_4 gCO_2e/pkm	N_2O gCO_2e/pkm	Total GHG gCO_2e/pkm
Domestic flights	**Average**	**124.0**	**0.2**	**1.1**	**125.2**
Short-haul flights	**Average**	**69.1**	**0.0**	**0.6**	**69.7**
	Economy	68.0	0.0	0.6	68.6
	First/Business	102.0	0.0	0.9	102.9
Long-haul flights	**Average**	**82.5**	**0.0**	**0.7**	**83.2**
	Economy	63.2	0.0	0.5	63.7
	Economy+	101.1	0.0	0.9	102.0
	Business	183.3	0.0	1.6	184.9
	First	252.8	0.0	2.1	255.0
International flights (non-UK)	**Average**	**77.2**	**0.0**	**0.7**	**77.8**
	Economy	59.1	0.0	0.5	59.6
	Economy+	94.5	0.0	0.8	95.4
	Business	171.4	0.0	1.5	172.8
	First	236.4	0.0	2.0	238.4

Note: Totals may vary from the sums of the components due to rounding in the more detailed dataset.

Table 46: Final average CO_2, CH_4 and N_2O conversion factors for air freight transport for 2025 GHG Conversion factors (excluding distance and RF uplifts)

Air Freight Mode	CO_2 kgCO_2/tkm	CH_4 kgCO_2e/tkm	N_2O kgCO_2e/tkm	Total GHG kgCO_2e/tkm
Passenger Freight				
Domestic flights	2.68	0.0034	0.0228	2.71
Short-haul flights	1.20	0.0001	0.0102	1.21
Long-haul flights	0.43	0.0000	0.0036	0.43
Dedicated Cargo				
Domestic flights	2.49	0.0031	0.0212	2.52
Short-haul flights	0.69	0.0000	0.0059	0.70
Long-haul flights	0.62	0.0000	0.0052	0.62
All Air Freight				
Domestic flights	2.49	0.0031	0.0212	2.52
Short-haul flights	0.69	0.0000	0.0059	0.70
Long-haul flights	0.49	0.0000	0.0041	0.49

Note: Totals may vary from the sums of the components due to rounding in the more detailed dataset.

Indirect/WTT Conversion factors from Air Transport

8.36. Indirect/WTT emissions factors for air passenger and air freight services include only emissions resulting from the fuel lifecycle (i.e. production and distribution of the relevant transport fuel). These indirect/WTT conversion factors were derived using simple ratios of the direct CO_2 conversion factors and the indirect/WTT conversion factors for aviation turbine fuel (kerosene) and the corresponding direct CO_2 conversion factors for air passenger and air freight transport in the "Business travel – air" and "Freighting goods" worksheets.

Other Factors for the Calculation of GHG Emissions

Great Circle Flight Distances

8.37. We wish to see standardisation in the way that emissions from flights are calculated in terms of the distance travelled and any uplift factors applied to account for circling and delay. However, we acknowledge that a number of methods are currently used.

8.38. An 8% uplift factor is used in the UK Greenhouse Gas Inventory to scale up Great Circle distances (GCD) for flights between airports to take into account indirect flight paths and delays, etc. This is lower than the 9-10% suggested by IPCC Aviation and the global atmosphere and has been agreed with DfT based on recent analysis as more appropriate for flights arriving and departing from the UK.

This factor has been used since the 2014 update of both the GHGI, and the GHG Conversion factors set.

8.39. It is not practical to provide a database of origin and destination airports to calculate flight distances in the GHG Conversion factors. However, the principal of adding a factor of 8% to distances calculated on a Great Circle is recommended (for consistency with the existing approach) to take account of indirect flight paths and delays/congestion/circling. This is the methodology recommended to be used with the GHG Conversion factors and is applied already to the conversion factors presented in the 2025 GHG Conversion factors set.

Non-CO_2 impacts and Radiative Forcing

8.40. The conversion factors provided in the 2025 GHG Conversion factors “Business travel – air” and “Freighting goods” worksheets refer to aviation's direct CO_2, CH_4 and N_2O emissions only. There is currently uncertainty over the magnitude of the other non-CO_2 radiative forcing effects of aviation (including water vapour, contrails, NO_X, etc.) which have been indicatively accounted for by applying a multiplier to account for CO_2 equivalent emissions in some cases.

8.41. The use of CO_2 equivalent emissions metrics such as the Global Warming Potential or the Global Temperature change Potential requires definition of a time horizon – the period over which the metric is calculated for. Such a choice is not a scientific one but a policy one. In the UNFCCC, the Global Warming Potential for 100 years is used (GWP100). The application of GWPs to short-lived climate forcers, such as the non-CO_2 effects of aviation has particular problems, but this is an active area of research. Nonetheless, aviation imposes other effects on the climate which are greater than that implied from simply considering its CO_2 emissions alone.

8.42. The application of an aggregate multiplier to take account of non-CO_2 effects is a possible way of illustratively taking account of the full climate impact of aviation. A multiplier is not a straightforward CO_2 equivalence metric, In particular, it implies that all other emissions and effects are directly linked to production of CO_2, which is not necessarily the case. Nor does it reflect accurately the different relative contribution of emissions to climate change over time, or reflect the potential trade-offs between the warming and cooling effects of different emissions.

8.43. On the other hand, consideration of the non-CO_2 climate change effects of aviation can be important in some cases, and there is currently no better way of taking these effects into account than applying an aggregate multiplier. A multiplier of 1.7 is recommended as a central estimate, based on the best available scientific evidence, as summarised in Table 47 and the GWP_{100} figure (consistent with UNFCCC reporting convention) in Table 48 below and in analysis by Lee et al. (2021).

8.44. It is important to note that **the value of this 1.7 multiplier is subject to significant uncertainty** and should only be applied to the CO_2 component of direct emissions (i.e. not also to the CH_4 and N_2O emissions components). The 2025 GHG Conversion factors provide separate conversion factors including this radiative forcing uplift in separate tables in the “Business travel – air” and

"Freighting goods" worksheets. The 1.7 multiplier is equally applicable to the CO_2 component of the scope 1 litres based emission factors for aviation turbine fuel and aviation spirit.

8.45. The non-CO_2 effects are likely to be more pronounced at higher altitudes. However, the current scientific evidence relates to aviation emissions in their entirety, and it provides no means of distinguishing the affects at different altitudes or during different phases of the flight. The multiplier is therefore recommended to be applied equally to all flights irrespective of distance or altitude and to equally to all phases of the flight, albeit accepting the approximations involved in this approach. Similarly, due to the flight altitudes, the non-CO_2 effects are likely to be less pronounced for turboprops than for commercial jet aircraft, but again the scientific evidence does not provide a mechanism to treat them differently, so the recommendation remains to apply the multiplier equally to all flights.

Table 47: Impacts of radiative forcing according to Lee et al., (2021)

ERF (mW m^{-2})	2018 [a]	2011 [a]	2005 [a]	Sensitivity to emissions	ERF/RF
Contrail cirrus	57.4 (17, 98)	44.1 (13, 75)	34.8 (10, 59)	9.36 x 10^{-10} mW m^{-2} km^{-1}	0.42
CO_2	34.3 (28, 40)	29.0 (24, 34)	25.0 (21, 29)		1.0
Short-term O_3 increase	49.3 (32, 76)	37.3 (24, 58)	33.0 (21, 51)	34.4 ± 9.9 mW m^{-2} (Tg (N) $yr^{-1})^{-1}$	1.37
Long-term O_3 decrease	-10.6 (-20, -7.4)	-7.9 (-15, -5.5)	-6.7 (-13, -4.7)	-9.3 ± 3.4 mW m^{-2} (Tg (N) $yr^{-1})^{-1}$	1.18
CH_4 decrease	-21.2 (-40, -15)	-15.8 (-30, -11)	-13.4 (-25, -9.4)	-18.7 ± 6.9 mW m^{-2} (Tg (N) $yr^{-1})^{-1}$	1.18
Stratospheric water vapor decrease	-3.2 (-6.0 -2.2)	-2.4 (-4.4, -1.7)	-2.0 (-3.8, -1.4)	-2.8 ± 1.0 mW m^{-2} (Tg (N) $yr^{-1})^{-1}$	1.18
Net NO_x	17.5 (0.6, 29)	13.6 (0.9, 22)	12.9 (1.9, 20)	5.5 ± 8.1 mW m^{-2} (Tg (N) $yr^{-1})^{-1}$	
Stratospheric H_2O increase	2.0 (0.8, 3.2)	1.5 (0.6, 2.4)	1.4 (0.6, 2.3)	0.0052 ± 0.0026 mW m^{-2} (Tg (H_2O) $yr^{-1})^{-1}$	---
Soot (aerosol-radiation)	0.94 (0.1, 4.0)	0.71 (0.1, 3.0)	0.67 (0.1, 2.8)	100.7 ± 165.5 mW m^{-2} (Tg (BC) $yr^{-1})^{-1}$	---
Sulfate (aerosol-radiation)	-7.4 (-19, -2.6)	-5.6 (-14, -1.9)	-5.3 (-13, -1.8)	-19.9 ± 16.0 mW m^{-2} (Tg (SO_2) $yr^{-1})^{-1}$	---
Sulfate and soot (aerosol-cloud)	----	----	----	----	---

ERF (mW m^{-2})	2018 [a]	2011 [a]	2005 [a]	Sensitivity to emissions	ERF/RF
Net ERF (only non-CO_2 terms)	66.6 (21, 111)	51.4 (16, 85)	41.9 (14, 69)	----	---
Net aviation ERF	100.9 (55, 145)	80.4 (45, 114)	66.9 (38, 95)	----	---
Net anthropogenic ERF in 2011	----	2290 (1130, 3330) [b]	----	----	---

[a] The uncertainty distributions for all forcing terms are lognormal except for CO_2 and contrail cirrus (normal) and Net NO_x (discrete pdf).

[b] Boucher et al., 2013. IPCC also separately estimated the contrail cirrus term for 2011 as 50 (20, 150) mW m^{-2}

Table 48: Aviation non-CO_2 emissions equivalence metrics for GWP, GTP and GWP* taken from Lee et al. (2021)

Metrics

ERF term	GWP_{20}	GWP_{50}	GWP_{100}	GTP_{20}	GTP_{50}	GTP_{100}
CO_2	1	1	1	1	1	1
Contrail cirrus (Tg CO_2 basis)	2.32	1.09	0.63	0.67	0.11	0.09
Contrail cirrus (km basis)	39	18	11	11	1.8	1.5
Net NO_x	619	205	114	-222	-69	13
Aerosol-radiation						
Soot emissions	4288	2018	1166	1245	195	161
SO_2 emissions	-832	-392	-226	-241	-38	-31
Water vapor emissions	0.22	0.10	0.06	0.07	0.01	0.008

CO_2-eq emissions (Tg CO_2 yr^{-1}) for 2018

ERF term	GWP_{20}	GWP_{50}	GWP_{100}	GTP_{20}	GTP_{50}	GTP_{100}	GWP^*_{100} (E^*_{CO2e})
CO_2	1034	1034	1034	1034	1034	1034	1034
Contrail cirrus (Tg CO_2 basis)	2399	1129	652	695	109	90	1834
Contrail cirrus (km basis)	2395	1127	651	694	109	90	1834
Net NO_x	887	293	163	-318	-99	19	339
Aerosol-radiation							
Soot emissions	40	19	11	12	2	2	20
SO_2 emissions	-310	-146	-84	-90	-14	-12	-158
Water vapor emissions	83	39	23	27	4	3	42
Total CO_2-eq (using km basis)	4128	2366	1797	1358	1035	1135	3111
Total CO_2-eq / CO_2	4.0	2.3	1.7	1.3	1.0	1.1	3.0

Note: GWP = Global Warming Potential, GTP = Global Temperature Potential

9. Bioenergy and Water

Section summary

9.1. Bioenergy conversion factors should be used for the combustion of fuels produced from recently living sources (such as trees) at a site or in an asset under the direct control of the reporting organisation. This section of the report describes both the direct (Scope 1) emissions and the indirect (Scope 3) emissions associated with bioenergy sources.

9.2. The section also includes factors for emissions associated with water supply, to account for water delivered through the mains supply network, and water treatment, which are used for water returned to the sewage system through mains drains. These are classified as Scope 3 emissions.

9.3. For the 2025 update, factors for water supply and water treatment are calculated using a revised methodology based on the 2021 data from the UK water companies Carbon Accounting Workbooks (CAW), including the actual volume of wastewater treated and drinking water supplied by each company.

9.4. Table 49 shows where the related worksheets to the bioenergy and water conversion factors are available in the online spreadsheets of the UK GHG Conversion factors.

Table 49: Related worksheets for bioenergy and water emission factors

Worksheet name	Full set	Condensed set
Bioenergy	Y	Y
WTT – bioenergy	Y	N
Water supply	Y	Y
Water treatment	Y	Y

Summary of changes since the previous update

9.5. There were no major methodological changes for bioenergy in the 2025 update. However, the Renewable Transport Fuel Obligation (RTFO) is likely to be highly variable year on year as suppliers can choose what types of biofuels and sources of biofuels, they want to use to fulfil that obligation. Therefore, more fuel sources and more advanced types of biofuels are continually brought into the market, so the underlying biofuels base is and will continue to change.

9.6. For water, factors reflect the latest data reported by the water companies, and this shows considerable interannual variation. In 2025, one water company reported higher GHG emissions intensity to reflect an improvement in their data and emissions calculations, and this has had a significant impact on the results.

General Methodology

9.7. The 2025 GHG Conversion factors provide tables of conversion factors for: water supply and treatment, biofuels, biomass and biogas.

9.8. The conversion factors for bioenergy incorporate emissions from the fuel life cycle and include net CO_2, CH_4, N_2O emissions and indirect/WTT emissions factors. These are presented for biofuels, biomass and biogas and still use the AR4 GWP values, while for water they are aligned with AR5 GWP values.

Water

9.9. The conversion factors for water supply and treatment in sections “Water supply” and “Water treatment” worksheets of the 2025 GHG Conversion factors were calculated based on 2023 data from UK water companies Carbon Accounting Workbooks (CAW). These data are used for reporting to the UK regulator (Ofwat) and all UK water companies use this common approach to reporting these data.[30]

9.10. The CAW data gives GHG intensity for each water company from water supply and wastewater treatment, accounting for emissions associated with offices and transport. The 2025 dataset includes the volume of wastewater treated and of drinking water supplied by each company. This is a more robust metric compared to previous years' which led to a revised methodology for 2023. This data is used to generate a weighted average of the volume of wastewater treated and drinking water supplied. It should also be noted that the data received from the water industry did not include complete reporting from all water companies, which introduces uncertainty in both water supply and water treatment estimates.

Biofuels

9.11. At the point of use, biofuels are defined as “net carbon zero” or “carbon neutral” as any CO_2 expelled during the burning of the fuel is cancelled out by the CO_2 absorbed by the feedstock used to produce the fuel during growth[31]. Therefore, all direct emissions from biofuels provided in the GHG Conversion factors dataset are only made up of CH_4 and N_2O emissions.

9.12. Unlike the direct emissions of CO_2, the CH_4 and N_2O emissions are not offset by absorption in the growth of the feedstock used to produce the biofuel. Specific emission factors are available for solid biomass and biogas but not for liquid and gaseous biofuels. In the absence of other information, these emission factors have been assumed to be equivalent to those produced by combusting the

[30] The data are not published in a suitable format for use for the GHG conversion factors. So, more suitable data were requested from, and provided by a contact at a water company in a personal communication. The individual companies' data are considered confidential, so can only be published as an aggregation.

[31] This is a convention required by international GHG Inventory guidelines and formal accounting rules.

corresponding liquid and gaseous fossil fuels (i.e. diesel, petrol, LNG or CNG) from the "Fuels" section.

9.13. The net GHG emissions for biofuels vary significantly depending on the feedstock source and production pathway. Therefore, for accuracy, it is recommended that more detailed/specific figures are used where available. For example, detailed indirect/WTT conversion factors by source/supplier are provided and updated regularly in the Quarterly Reports on the RTFO website (DfT, 2024).

9.14. The indirect/WTT/fuel lifecycle conversion factors for biofuels were based on UK average factors from the Quarterly Reports[32] on the Renewable Transport Fuel Obligation (RTFO) (DfT, 2024). These average factors and the direct CH_4 and N_2O factors are presented in Table 50.

9.15. In addition to the direct and indirect/WTT conversion factors provided in Table 50, conversion factors for the Out of Scope CO_2 emissions have also been provided based on data sourced from the UK GHG Inventory (GHGI) for 2022 (managed by Ricardo Energy & Environment) and the JEC WTT v5 study (JEC WTW v5, 2020).

Table 50: Fuel lifecycle GHG Conversion factors for biofuels

Biofuel	**Emissions Factor, gCO_2e/MJ**					
	RTFO Lifecycle (1)	Direct CH_4 (2)	Direct N_2O (2)	Direct CO_2 (2*)	Total Lifecycle	Direct CO_2 Emissions (Out of Scope (3))
Avtur (renewable)	15.26	0.04	0.68	0.00	15.98	71.74
Biodiesel HVO	16.45	0.01	1.03	0.00	17.48	70.83
Biodiesel ME	11.93	0.01	1.03	4.02	16.99	72.16
Biodiesel ME (from Tallow)	16.08	0.01	1.03	4.02	21.14	72.16
Biodiesel ME (from used cooking oil)	10.67	0.01	1.03	4.02	15.73	72.16
Bioethanol	28.91	0.22	0.20	0.00	29.33	71.37
Biomethane (compressed)	15.80	0.08	0.03	0.00	15.90	55.28
Biomethane (liquified)	23.90	0.08	0.03	0.00	24.01	56.80
Biopropane	6.61	0.05	0.04	0.00	6.70	64.51

[32] These cover the period from January to December 2023 and were the most recent figures available at the time of production of the 2025 GHG Conversion factors. The report is available from: Renewable fuel statistics - GOV.UK (www.gov.uk)

Development diesel	23.32	0.01	1.03	0.00	24.36	73.54
Methanol (bio)	37.60	0.22	0.20	0.00	38.02	68.92
Development petrol	23.10	0.22	0.20	0.00	23.52	70.21
Off road biodiesel	11.93	0.01	1.03	4.02	16.99	72.16

Notes:

(1) Based on UK averages from the RTFO Quarterly Report from DfT (DfT, 2024).

(2) Based on corresponding emission factors for diesel, petrol, LNG or CNG. *Biodiesel, as of April 2020, is now accounting for fossil component of biodiesel to align with the UK GHGI estimates; based on stoichiometric analysis of chemical compounds.

(3) The Total GHG emissions outside of the GHG Protocol Scope 1, 2 and 3 is the actual amount of CO_2 emitted by the biofuel when combusted. This will be counter-balanced by the equivalent to the CO_2 absorbed in the growth of the biomass feedstock used to produce the biofuel. These factors are based on data from the JEC Well to Tank Study (v5).

Other biomass and biogas

9.16. A number of different biomass types can be used in dedicated biomass heating systems, including wood logs, chips and pellets, as well as grasses/straw or biogas. Conversion factors produced for these bioenergy sources are presented in the "Bioenergy" worksheet of the 2025 GHG Conversion factors set.

9.17. The indirect/WTT/fuel lifecycle conversion factors for biomass, except for wood logs, are sourced from the Ofgem solid and gaseous biomass carbon calculator (Ofgem, 2015). This calculator has been developed to support operators determining the GHG emissions associated with the cultivation, processing and transportation of their biomass fuels.

9.18. Indirect/WTT/fuel lifecycle conversion factors for wood logs, which are not covered by the Ofgem tool, were obtained from the Biomass Environmental Assessment Tool ($BEAT_2$) (Forest Research, 2016a), provided by Defra. And for the indirect conversion factor for biogas the RTFO standard data statistics has been used this year using the value for biowaste - close digestate, no off-gas combustion (DfT, 2023).

9.19. The direct CH_4 and N_2O conversion factors presented in the 2025 GHG Conversion factors are based on the conversion factors used in the UK GHG Inventory (GHGI) for 2022 (Ricardo, 2025).

9.20. In some cases, calorific values were required to convert the data into the required units. The most appropriate source was used, and this was either from the Forest Research (Forest Research, 2023), DUKES (Table A.1) or Swedish Gas Technology Centre 2012 (which is also backed up by other data sources). The values used and their associated moisture contents are provided in Table 51.

9.21. In addition to the direct and indirect/WTT conversion factors provided, conversion factors for the out of scope CO_2 emissions are also provided in the 2025 GHG Conversion factors (see "Outside of Scopes" and the relevant notes on the page), based on data sourced from Forest Research, the Forestry Commission's research agency (previously BEC) (Forest Research, 2016a).

Table 51: Fuel sources and properties used in the calculation of biomass and biogas emission factors

Biomass	Moisture content	Net calorific value (GJ/tonne)	Source
Wood chips	25% moisture	13.6	Forestry Research
Wood logs	Air dried 20% moisture	14.7	NAEI
Wood pellets	10% moisture	17.3	DUKES
Grass/Straw	10% moisture	13.4	NAEI
Biogas	Based on 65% CH_4	20.0	Swedish Gas Technology Centre 2012
Landfill gas	Based on 40% CH_4	12.3	Swedish Gas Technology Centre 2012

10. Overseas Electricity Emission Factors

Section summary

10.1. This section contains guidance for users on how to find Scope 2 conversion factors for electricity generation in overseas countries and how to calculate the indirect/WTT emissions associated with these activities. These should be used for sites owned or controlled by the reporting organisation in another country. The Scope 2 indirect factors are no longer included within the Conversion factors but are available for sale from the CO_2 Emissions from Fuel Combustion online data service at the International Energy Agency (IEA) website. Indirect/WTT factors are no longer being provided as part of the UK GHG conversion factors. Instead, guidance will be provided in the sections below on how to manually calculate the desired factors.

10.2. The related worksheet for this section is the "WTT – Overseas electricity", available only in the full set of the UK GHG Conversion factors.

Summary of changes since the previous update

10.3. Indirect/WTT factors are no longer being provided as part of the UK GHG conversion factors. Instead, guidance will be provided in the sections below on how to manually calculate the desired factors.

Direct Emissions and Emissions resulting from Transmission and Distribution Losses from Overseas Electricity Generation

10.4. UK companies reporting on their emissions may need to include emissions resulting from overseas activities. Whilst many of the fuel conversion factors are likely to be similar for fuels used in other countries, electricity conversion factors vary considerably due to fuel mix.

10.5. However, the overseas electricity factors have not been provided after the 2015 update due to a change in the licencing conditions for the underlying International Energy Association (IEA) dataset upon which they were based.

10.6. The dataset on electricity conversion factors from the IEA has previously been identified as the best available consistent dataset for electricity emissions factors. These factors are a time series of combined electricity CO_2 conversion factors per kWh GENERATED (Scope 2), and corresponding conversion factors for losses in Transmission and Distribution (T&D) (Scope 3). These can be purchased from the IEA website [33].

10.7. Since the 2018 update year, the emissions associated with electricity losses during transmission and distribution of electricity between the power station and

[33] Available here: https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser

an organisation's site(s) are also provided in the IEA dataset, these are also now no longer provided in the UK GHG Conversion factors dataset.

10.8. The conversion factors supplied by the IEA do not include indirect/WTT emissions.

10.9. For European countries, an alternative data set is available for free from the Association of Issuing Bodies (AIB). Within the 2021 edition of the European Residual Mix report[34], Table 5 presents the production mix for each country and their direct CO_2 conversion factor (the ‘CO_2 (gCO_2/kWh)’ column). These values differ from the IEA values due to differences in methodology.

Indirect/WTT Emissions from Overseas Electricity Generation

10.10. As of the 2022 publication of the UK GHG Conversion Factors, indirect/WTT emission factors for overseas electricity generation is no longer provided. Instead, the method for calculating the factors manually will be provided. The methodology used in previous editions of the UK GHG conversion factors was to take the direct emission factor for the country in questions and multiply it by the ratio between the UK’s indirect/WTT factor and the UK’s direct factor. This approach allows an indirect factor to be estimated for a country without fully modelling the electricity generation system of the country. Examples of the calculations are provided below.

10.11. As the Indirect/WTT factor for UK Electricity is no longer updated annually, the ratio between the published indirect/WTT factor and the direct factor in the latest year will not be suitable for users looking to calculate an estimate for the indirect/WTT factor for another country. Therefore, users are advised to use the ratio for the year 2020 from the 2022 publication of the UK Conversion Factors going forward, as described below.

10.12. The ratio between the UK’s Indirect/WTT factor and direct factor is presented in Table 11 in the 2022 publication of the UK GHG Conversion Factors, for 2020 this weighted average is 24.19%. If, for example, the direct factor for French electricity generation was 61 gCO_2e/kWh then the Indirect/WTT factor can be calculated as follows:

$$WTT = Direct \times UK \frac{WTT}{Direct} Ratio = 61 \times \frac{24.19}{100} = 14.76\ gCO_2e/kWh$$

[34] Available here: https://www.aib-net.org/facts/european-residual-mix/2021

10.13. To calculate the transmission and distribution (T&D) WTT factor, the percentage of losses for the country must be applied to the direct factor. For example, if the French electricity losses were 8%, the WTT T&D Losses factor could be calculated as follows:

$$WTT_{T\&D} = \left(\frac{Direct}{1 - Losses} - Direct\right) \times UK\,\frac{WTT}{Direct}Ratio = \left(\frac{61}{1 - \frac{8}{100}} - 61\right) \times \frac{24.19}{100} = 1.28\ gCO_2e/kWh$$

11. Hotel Stay

Section summary

11.1. This section describes the calculation of conversion factors for Hotel Stays, which should be used to report the Scope 3 emissions associated with overnight hotel stays for business travel.

11.2. These factors appear in the "Hotel Stay" worksheet, available only in the full set of the UK GHG Conversion factors set.

11.3. Hotel Stay conversion factors remain constant since the publication of 2022 GHG Conversion factors.

Summary of changes since the previous update

11.4. Hotel Stay conversion factors are not all aligned with the AR5 GWPs in the 2025 update, because the data from Hotel Sustainability Benchmarking Index 2021 were in CO_2e with no breakdown of CH_4 and N_2O emissions. The conversion factors of different countries could be in either AR4 or AR5 basis, depending on the GWPs used by the reporting hotels if the data were reported in CO_2e instead of the raw values of CO_2, CH_4 and N_2O emissions.

Direct emissions from a hotel stay

11.5. All the hotel stay conversion factors presented in the 2025 GHG Conversion factors are in a CO_2e basis. These are taken directly from the Cornell Hotel Sustainability Benchmarking Index (CHSB) Tool, produced by the International Tourism Partnership (ITP) and Greenview (ITP/Greenview, 2021). The factors use annual data comprising several international hotel organisations.

11.6. For the 2022 GHG Conversion factors the median benchmark for each country, for all hotel classes included within the tool, was used.

11.7. The following five steps were carried out in the CHSB study to arrive at the conversion factors included within the 2022 GHG Conversion factors:

a) **Harmonising.** The data received was converted into the same units and then converting to kg CO_2e.
b) **Validity tests** were carried out to remove outliers or errors from the data sets received.
c) **Geographic and climate zone segmentation**. The data sets were grouped by location and climate zone.
d) **Property segmentation**. Hotels were grouped by property segment, applying a revenue-based approach and property-type segmentation used by STR Global (using 2020 global chain scales), the asset class segmentation of full-service and limited-service hotels, and a global data set of star levels for hotels as identified by Expedia.

e) **Minimum output thresholds**. A minimum threshold of eight hotels per geographical region was required before it was populated within the tool. If there were less than eight hotels, these were excluded from the final outputs.

11.8. It should be noted that there are certain limitations with the CHSB tool used to derive the 2022 GHG Conversion factors. The main limitations are detailed below:

a) The factors are skewed toward large, more upmarket hotels and to branded chains. This is because it was mainly large owners or operators of hotels who submitted the aggregated data sets. Hotels in the lower tier segments are not as strongly represented in these data.
b) The data sets used to derive the factors have not been verified and therefore it cannot be concluded to be 100% accurate.
c) 65% of the benchmarks are within United States geographies. The datasets used are updated each year, therefore it is expected that a wider range of countries will be covered in the future and the tool aims to seek data sets from outside the U.S in future years.
d) The factors do not distinguish a property's amenities except for outsourced laundry services, which are taken into consideration. The factors are an aggregation of all types of hotels within the revenue-based segmentation and geographic location. Which means it is very difficult to compare two hotels since some may contain distinct attributes, (such as restaurants, fitness centres, swimming pool and spa) while others do not.
e) At present, there is no breakdown of CH_4 and N_2O emissions, plus there are also no indirect/ WTT factors.

11.9. For more information about how the factors have been derived, please see (ITP/Greenview, 2021), where more granular data is also available by city and segment.

12. Material Consumption/Use and Waste Disposal

Section summary

12.1. Material use conversion factors should be used **only** to report on procured products and materials based on their origin (that is, comprised of primary material or recycled materials). The factors are **not** suitable for quantifying the benefits of collecting products or materials for recycling.

12.2. For primary materials, these factors cover the extraction, primary processing, manufacture and transportation of materials to the point of sale, not the materials in use. For secondary materials, the factors cover sorting, processing, manufacture and transportation to the point of sale, not the materials in use. These factors are useful for reporting efficiencies gained through reduced material procurement or the benefit of procuring items that are the product of a previous recycling process.

12.3. Waste-disposal figures should be used for Greenhouse Gas Protocol reporting of Scope 3 emissions associated with end-of-life disposal of different materials. With the exception of landfill, these figures only cover emissions from the collection of materials and delivery to the point of treatment or disposal. **They do not cover the environmental impact of different waste management options**. They are suitable **only** for Scope 3 reporting of emissions impacts under the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (‘the Scope 3 Standard’)[35].

12.4. These factors appear in the “Material use” and “Waste disposal” worksheets, available in both the full and condensed sets of the UK GHG Conversion factors

12.5. Users wishing to quantify the impact of different waste management options may wish to use WRAP Carbon Waste and Resources Metric (CarbonWARM)[36]. Note that CarbonWARM outputs cannot be used for reporting Scope 3 Greenhouse Gas emissions.

Summary of changes since the previous update

12.6. Minor updates have been made to the Material Consumption/Use and Waste Disposal factors to account for this 2025 update of transport and electricity generation factors. Emission factors have been updated to reflect new data for HVGs; this affects emissions from the transportation of materials and waste.

[35] https://ghgprotocol.org/corporate-value-chain-scope-3-standard

[36] https://www.wrap.ngo/resources/report/carbon-waste-and-resources-metric-carbonwarm2

The following changes have been made to the Material Use factors since the 2024 update.

12.7. Factors for paper, board, plastics, wood, and the manufacturing element of the concrete factor have been revised to bring the values into line with the latest values in the ecoinvent lifecycle database.

12.8. The steel factor has been updated based on the latest data releases from World Steel.

12.9. UK electricity factors have been updated to 2024 and WTT emissions added. European electricity factors have been updated based on European Environment Agency data.

The following changes have been made to the Waste Disposal factors since the 2024 update.

12.10. Incineration with energy recovery: This category was named 'combustion' in previous years. It has been renamed to clarify that energy recovery is assumed to take place. The emissions attributed to the company which generates the waste cover only the collection of waste from their site and deposit at the first point of processing. The emissions from combustion would be zero for the reporting organisation, as those emissions would instead be allocated to the end user of the energy. At present there is no factor for incineration without energy recovery, but this may be added in future years.

12.11. Updates have been made to the assumptions relating to emissions from mechanical sorting, which reflect differences in assumptions about UK grid intensity and power usage in material recovery facilities (MRFs). The previous mechanical sorting factor (3.44 kg per tonne of input) has been replaced with a new mechanical sorting factor (1.64 per tonne of input) which is taken from ‘Analysis of material recovery facilities for use in life-cycle assessment’ (Pressley & al, 2015). This update has had impacts on open loop, closed loop and incineration with energy recovery factors which show a substantial proportional decrease in emissions per tonne, although in absolute terms the change is smaller (c. 2kg per tonne).

Emissions from Material Use and Waste Disposal

12.12. The GHG conversion factors for material consumption/use and waste disposal have been aligned with the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (‘the Scope 3 Standard’)[37]. This sets down rules on accounting for emissions associated with material consumption and waste management.

12.13. The company sending waste for recycling **does not receive any benefit to its carbon account** from recycling as the figures for waste disposal no longer include the potential benefits where primary resource extraction is replaced by recycled material. Under this accounting methodology, the organisation using recycled

[37] https://ghgprotocol.org/corporate-value-chain-scope-3-standard

materials will see a reduction in their account where this use is in place of higher impact primary materials.

12.14. Whilst the factors are appropriate for accounting, they are therefore **not appropriate for informing decision making on alternative waste management options** (i.e. they do not show the impact of waste management options).

12.15. All figures expressed are kilograms of carbon dioxide equivalent (CO_2e) per tonne of material. This includes the Kyoto protocol basket of greenhouse gases. Please note that biogenic[38] CO_2 has been excluded from these figures.

12.16. The information for material consumption presented in the conversion factors spreadsheet has been separated from the emissions associated with waste disposal to allow separate reporting of these emission sources, in compliance with the Scope 3 Standard.

12.17. Businesses must quantify emissions associated with both material use and waste management in their Scope 3 accounting, to fully capture changes due to activities such as waste reduction.

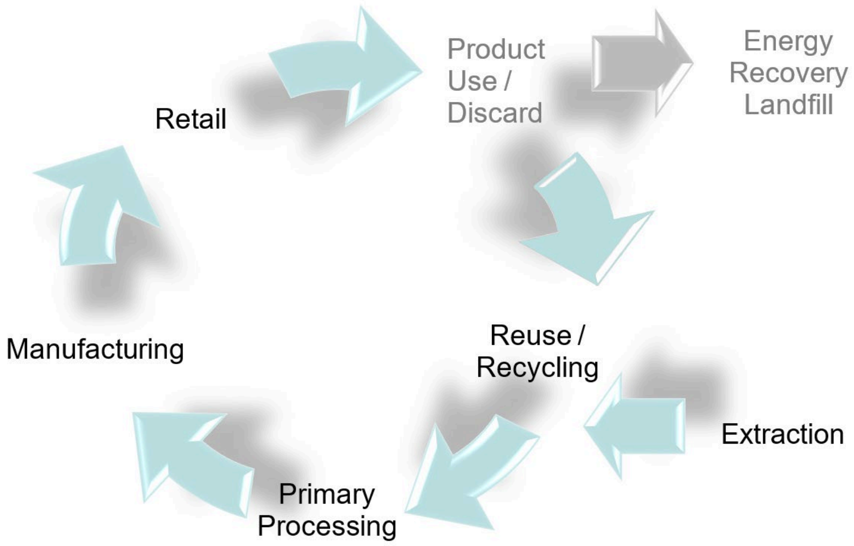
12.18. The following subsections summarise the methodology, key data sources and assumptions used to define the emission factors.

Material Consumption/Use

12.19. Figure 5 shows the boundary of greenhouse gas emissions summarised in the material consumption table.

[38] Biogenic CO_2 is the CO_2 absorbed and released by living organisms during and at the end of their life. By convention, this is assumed to be in balance in sustainably managed systems.

Figure 5: Boundary of material consumption data sets



Notes: Arrows represent transportation stages; greyed items are excluded.

12.20. The conversion factors presented for material consumption cover all GHG emissions from the point of raw material extraction through to the point at which a finished good is manufactured and provided for sale. Therefore, commercial enterprises may use these factors to estimate the impact of goods they procure. Organisations involved in manufacturing goods using these materials should note that if they separately report emissions associated with their energy use in forming products with these materials, there is potential for double counting. As many of the data sources used in preparing the tables are confidential, we cannot publish a more detailed breakdown. However, the standard assumptions made are described below.

12.21. Conversion factors are provided for both recycled and primary materials. To identify the appropriate carbon factor, an organisation should seek to identify the level of recycled content in materials and goods purchased. Under this accounting methodology, the organisation using recycled materials in place of primary materials receives the benefit of recycling in terms of reduced Scope 3 emissions.

12.22. These factors are estimates to be used in the absence of data specific to your goods and services. If you have more accurate information for your products, then please refer to the more accurate data for reporting your emissions.

12.23. Information on raw material extraction and manufacturing impacts is commonly sourced from the same reports, typically life cycle inventories published by trade associations. The sources utilised in this study are listed in Appendix 1 to this report. The stages covered include mining activities for non-renewable resources, agriculture and forestry for renewable materials, production of materials used to make the primary material (e.g. soda ash used in glass production) and primary production activities such as casting metals and producing board. Intermediate transport stages are also included. Full details are available in the referenced reports.

12.24. Conversion factors provided include emissions associated with product forming.

12.25. Table 52 identifies the transportation distances and vehicle types which have been assumed as part of the conversion factors provided. The impact of transporting the raw material (e.g. forestry products, granules, glass raw materials) is already included in the manufacturing profile for all products. The transportation tables and Greenhouse Gas Protocol guidelines on vehicle emissions have been used for most vehicle emission factors.

Table 52: Distances and transportation types used in material use EF calculations

Destination / Intermediate Destination	One Way Distance	Mode of transport	Source
Transport of raw materials to the factory	122km	Average, all HGVs	(DfT, 2010) Based on average haulage distance for all commodities, not specific to the materials in the first column.
Distribution to Retail Distribution Centre & to retailer	96km	Average, all HGVs	(McKinnon, 2007), (IGD, 2018)

12.26. Transport of goods by consumers is excluded from the factors presented, as is the use of the product.

Waste Disposal

12.27. As defined under the Scope 3 standard, emissions associated with recycling and energy recovery **are attributed to the organisation which uses the recycled material or which uses the waste to generate energy**. The emissions attributed to the company which generates the waste **cover only the collection of waste from their site and deposit at the first point of processing (e.g. MRF)**[39]. This does not mean that emissions from waste management or recycling are zero or are not necessary; it simply means that, in accounting terms, these emissions are for another organisation to report.

12.28. Landfill emissions remain within the accounting Scope of the organisation producing waste materials. Factors for landfill are provided within the waste disposal sheet in the 2025 GHG Conversion Factors. These factors are drawn directly from MELMod, which contains information on landfill waste composition and material properties, with the addition of collection and transport emissions.[40]

12.29. This means that the waste disposal factors exclude the majority of emissions from waste management and **cannot be used to compare the impacts of different**

[39] See, for example, notes a and b to example 5.1 (p.75) in *Technical Guidance for Calculating Scope 3 Emissions* (World Resources Institute, 2013).

[40] MELMod accounts for biogenic methane emissions (corrected to account for capture and oxidation) but excludes biogenic CO2 removals and emissions. For more information see Brown and Leach (2008).

waste management options or processes. They may be used **only** for the purposes of reporting Scope 3 emissions under the Greenhouse Gas protocol.

12.30. Figures for Refuse Collection Vehicles have been taken from the Environment Agency's Waste and Resource Assessment Tool for the Environment (WRATE) (Environment Agency, 2010).

12.31. Transport distances for waste were estimated using a range of sources, principally data supplied by the Environment Agency for use in the WRATE (2005) tool (Environment Agency, 2010). The distances adopted are shown in Table 53.

Table 53: Distances used in the calculation of waste emission factors

Destination / Intermediate Destination	One Way Distance	Mode of transport	Source
Collection and transport to transfer station or MRF	25km by Road	26 Tonne GVW Refuse Collection Vehicle, maximum waste capacity 12 tonnes	Environment Agency (2010)
Distance from transfer station to landfill or composting site	10km by Road	Bulk transport	Environment Agency (2010)
Collection and transport for inert waste recycling	12.85km by Road	4 axle rigid tippers and an average load of 20 tonnes, round trip of 45.7km x 2, 22 tonne average load)	Aggregain (2010)
Distance to inert waste landfill	16.1km by Road	4 axle rigid tippers and an average load of 20 tonnes, round trip of 45.7km x 2, 22 tonne average load)	Aggregain (2010)

12.32. Road vehicles are volume-limited rather than weight limited. An average loading factor (including return journeys) is used for all HGVs, based on the HGV factors provided in the 2025 Conversion factors. Waste vehicles leave a depot empty and return fully laden. A 50% loading assumption reflects the change in load over a collection round which could be expected.

13. Fuel Properties

Section summary

13.1. The fuel properties can be used to determine the typical calorific values / densities of most common fuels.

13.2. These factors appear in the "Fuel properties" worksheet, available in both the full and condensed sets of the UK GHG Conversion factors set.

Summary of changes since the previous update

13.3. Fuel property data for the vast majority of fuels uses data from the UK GHG Inventory (GHGI) (Ricardo, 2025). The GHGI data is largely based on DUKES, but in some cases deviates, either to use data consistent with the carbon content data source (such as for power stations coal, which uses EU ETS data), or in cases where there are apparent inconsistencies in the time series, as the GHGI must present a consistent time series from 1990. This change will improve consistency between the GHGI and the Conversion Factors.

General Methodology

13.4. The following standard properties for key fuels are provided in the UK GHG Conversion factors:

a) Gross Calorific Value (GCV) in units of GJ/tonne, kWh/kg and kWh/litre;

b) Net Calorific Value (NCV) in units of GJ/tonne, kWh/kg and kWh/litre;

c) Density in units of litres/tonne and kg/m^3.

13.5. The standard conversion factors from the GHGI are now provided on a net energy basis. These are converted into different energy, volume and mass units for the various data tables using the information on these fuel properties (i.e. Gross and Net Calorific Values (CV), and fuel densities in litres/tonne) from UK GHGI data and in some cases data from DESNZ's Digest of UK Energy Statistics (DESNZ, 2024).

13.6. The fuel properties of most biofuels are predominantly based on data from JEC - Joint Research Centre-EUCAR-CONCAWE collaboration, "Well-to-Wheels Analysis of Future Automotive Fuels and Powertrains in the European Context" Version 5, 2020 (Report EUR 30269 EN - 2020) (JEC WTW v5, 2020). The exception is for methyl-ester based biodiesels and bioethanol, where values for NCV and GCV are taken from the UK GHGI.

13.7. Fuel properties, both density and CV, for wood chips (25% moisture content) come from the Forest Research (previously Biomass Energy Centre (BEC)[41]. The density of wood logs (20% moister content), wood chips (25% moister content)

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[41] Available at: https://www.gov.uk/government/organisations/forestry-commission

and grasses/straw (25% water content) are also sourced from the Forest Research[42].

[42] Available at: https://www.gov.uk/government/organisations/forestry-commission

14. SECR kWh Conversion factors

Section summary

14.1. The new Streamlined Energy and Carbon Reporting (SECR) came into effect on the 1 April 2019. One of the requirements of the guidance is to report GHG emissions from activities for which the company is responsible. SECR obligations differ between quoted and unquoted organisations covering Scope 1, Scope 2 and some Scope 3 emissions. Most will need to calculate the GHG emissions for the combustion of fuel (including transport fuel) and the operation of any facility; together with the annual emissions from the purchase of electricity, heat, steam or cooling by the company for its own use. See the Environmental Reporting Guidelines, (BEIS, 2019), for more details.

14.2. The SECR also requires the total energy use that is used to calculate these GHG emissions to be provided in kilowatt hours (kWh).

14.3. When organisations are calculating the GHG emissions associated with fuels (Scope 1), bioenergy (Scope 1), electricity (Scope 2) and heat and steam (Scope 2), they will either already have the kWh values or will be able to convert units such as GJ, litres or tonnes using the fuel properties or conversion data provided at the end of the conversion factors spreadsheet.

14.4. For transport, companies may have two types of data which they can use to calculate vehicles emissions (cars, motorcycles, vans and HGVs owned or controlled by the company):

a) Fuel consumption data in litres or kWh. In the instance of litres, this can easily be converted to kWh using the fuel properties provided at the end of the conversion factors spreadsheet. This is the preferred and more accurate method to use.
b) Journey distance in km or miles. If a company does not have fuel consumption data (option a), they may have a record of the total distance travelled, for example from expense claims. In this instance, the km or miles data will need to be converted into kWh. This will require an additional factor, which is what we have provided in the SECR factors worksheet.

Table 54: Related worksheets to SECR kWh emissions factors

Worksheet name	Full set	Condensed set
SECR kWh pass & delivery vehs	Y	Y
SECR kWh UK electricity for EV	Y	Y

14.5. SECR kWh conversion factors have been calculated for passenger and delivery vehicles including; cars, motorcycles, vans and HGVs.

14.6. The factors are split out between two worksheets:

a) "SECR kWh pass & delivery vehs" worksheet contains cars, motorcycles, vans and HGVs, including electric vehicles (i.e. Plug-in Hybrid Electric Vehicles / Range-Extended Electric Vehicles and Battery Electric Vehicles) where the kWh factors presented only include the conventional fuel use (i.e. petrol or diesel)
b) "SECR kWh UK electricity for EV" worksheet contains only the kWh factors for the electricity consumed by the electric vehicles.

Summary of changes since the previous update

14.7. There were no major methodological changes in the 2025 update.

General Methodology

14.8. The factors are calculated using a two-step approach:

Step 1 - Convert km or miles data into kg CO_2 using the appropriate transport GHG conversion factor. These are the factors found within the passenger and delivery vehicles worksheets.

Step 2 – Divide the kg CO_2 figure, from step 1, by the fuel net kWh conversion factor (e.g. diesel or petrol). These are the figures found within the fuel worksheet.

14.9. The CO_2 GHG conversion factor for some vehicle types are calculated using a mixture of fuels, such as hybrid vehicles, or for those where the fuel is unknown. In these instances, the kWh conversion factor used in step 2 is calculated using the appropriate percentage fuel split used in calculating the GHG conversion factors.

14.10. The calculation of the SECR kWh conversion factors are based on using the CO_2 (and not the CO_2e) factors. This is because the CO_2e factor is comprised of the CO_2, CH_4 and N_2O factors and the CH_4 and N_2O emissions are not directly linked to the energy consumption but they are related to the specific (exhaust) emission after-treatment systems. For different vehicle types, the ratio is different for the same fuel type. Hence the calculation uses the ratio of CO_2 with the average fuel conversion factor.

15. Homeworking

Section summary

15.1. This section describes the calculation of conversion factors for Homeworking, which should be used to report the Scope 3 emissions associated with employees working remotely from home.

15.2. These factors appear in the “Homeworking” worksheet, available only in the full set of the UK GHG Conversion factors set.

15.3. Homeworking conversion factors remain constant since the publication of 2022 GHG Conversion factors but have been updated from AR4 to AR5 GWP values.

General Methodology

15.4. The methodology is based on the “Homeworking emission Whitepaper” (EcoAct, 2020). These factors estimate the incremental energy use from office equipment and home heating by homeworking employees which would not have occurred in an office-working scenario.

15.5. All the Homeworking conversion factors presented in the 2025 GHG Conversion factors are in a CO_2e basis.

15.6. The Homeworking conversion factors are provided on a 'Full-time Equivalent (FTE) working hour' basis, representing the GHG emissions from one hour of work by one full-time employee.

15.7. There are several assumptions used in the estimation of the Homeworking conversion factors, as listed below. These assumptions would be updated in the future if there are data sources that are more updated or accurate.

15.8. Office equipment is an estimation of energy used by a homeworking employee. GHG conversion factors for electricity consumption come from the UK GHG Conversion factors model outputs for UK Electricity. There are 3 assumptions:

a) assumed that a homeworking employee only uses energy for a laptop or PC, monitor, phone, printer and lighting;

b) assumed that the energy used by a homeworking employee is 140W, same as the energy used by a workstation (a laptop or PC, monitor, phone and printer). Electricity use data for a workstation came from CIBSE Guide F (CIBSE, 2012);

c) assumed that the energy used for lighting is 10W per homeworking employee (an assumption by EcoAct);

15.9. Home heating is an annual average of energy used for heating estimated using data from "Typical Domestic Consumption values 2020" (Ofgem, 2020) and

"Estimates of heat use in the United Kingdom in 2013" (DECC, 2014). GHG conversion factors for natural gas consumption come from the UK GHG Conversion factors model outputs for Fuels. There are 4 assumptions:

a) assumed that all home heating in the UK is powered by natural gas (survey showed that 86% of UK homes are heated by natural gas (DLUHC, 2021);

b) assumed that in the UK, heating is used 6 months per year (October to March);

c) assumed that heating is used 10 hours per day during heating season; and

d) assumed that one-third of the employees have at least one household member who would normally remain at home during the day (result from an internal staff survey done by NatWest Group in 2020), therefore only two-third (66.7%) of the employees moving to homeworking would result in incremental heating energy.

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Appendix 1. Additional Methodological Information on the Material Consumption/Use and Waste Disposal Factors

This section explains the methodology for the choice of data used in the calculation of carbon emissions used in the “Material use” and “Waste disposal” worksheets. Section 1.1 details the indicators used to assess whether data met the data quality standards required for this project. Section 1.2 states the sources used to collect data. Finally, Section 1.3 explains and justifies the use of data which did not meet the data quality requirements.

1.1 Data Quality Requirements

Data used in this methodology should, so far as is possible, meet the data quality indicators described in Table 1.1 below.

Table 1.1: Data Quality Indications for the waste management GHG factors

Data Quality Indicator	Requirement	Comments
Time-related coverage	Data less than 5 years’ old	Ideally, data should be less than five years old. However, the secondary data in material eco-profiles is only periodically updated. In cases where no reliable data is available from within the five-year period, the most recent data available have been used. In cases where use of data over five years old creates specific issues, these are discussed below under “Use of data below the set quality standard”. All data over five years old has been marked in the references with an asterisk within the 2.0 Data Sources section.
Geographical coverage	Data should be representative of the products placed on the market in the UK	Many datasets reflect European average production.
Technology coverage	Average technology	A range of information is available, covering best in class, average and pending technology. Average is considered the most appropriate but may not reflect individual supply chain organisations.
Precision/ variance	No requirement	Many datasets used provide average data with no information on the range. It is therefore not possible to identify the variance.

Data Quality Indicator	Requirement	Comments
Completeness	All datasets must be reviewed to ensure they cover inputs and outputs pertaining to the life cycle stage	
Representative-ness	The data should represent UK conditions	This is determined by reference to the above data quality indicators.
Consistency	The methodology has been applied consistently.	
Reproducibility	An independent practitioner should be able to follow the method and arrive at the same results.	
Sources of data	Data will be derived from credible sources and databases	Where possible data in public domain will be used. All data sources referenced.
Uncertainty of the information		Many data sources come from single sources. Uncertainty will arise from assumptions made and the setting of the system boundaries.

1.2 Data Sources

Data has been taken from a combination of trade associations, who provide average information at a UK or European level, data from the Ecoinvent database and reports/data from third parties (e.g. academic journals, Intergovernmental Panel on Climate Change). Data on wood and many products are taken from published life cycle assessments as no trade association eco-profile is available. Data sources for transport are referenced in Section 12. Data on waste management options has been modelled using Ecoinvent data and WRATE. Some data sources used do not meet the quality criteria. The implications of this are discussed in the following section.

1.3 Use of data below the set quality standard

Every effort has been made to obtain relevant and complete data for this project. For the majority of materials and products data which fits the quality standards defined in Appendix 1.1 above are met. However, it has not always been possible to find data which meets these standards in a field which is still striving to meet the increasing data demands set by science and government. This section details data which do not meet the expected quality standard set out in the methodology of this project but were never-the-less included because they represent the best current figures available. The justification for inclusion of each dataset is explained. The most common data quality issues encountered concerned data age and availability.

1.4 Wood and Paper data

Data on different types of wood has been used in combination with information on the composition of wood waste in the UK (WRAP, 2009) to provide a figure which represents a best estimate of the impact of a typical tonne of wood waste.

Many trade associations publish data on the impact of manufacturing 100% primary and 100% recycled materials. However, the bodies representing paper only produce industry average profile data, based on a particular recycling rate.

Furthermore, paper recycling in particular is dependent on Asian export markets, for which information on environmental impacts of recycling or primary production is rare. This means that the relative impact of producing paper from virgin and recycled materials is difficult to identify. The figure for material consumption for paper represents average production, rather than 100% primary material, so already accounts for the impact of recycling. Caution should therefore be taken in using these numbers.

1.5 Excluded Materials and Products

For some materials and products, such as automotive batteries and fluorescent tubes, no suitable figures have been identified to date.

Table 1.2 Data Sources

Material	Reference
Aluminium cans and foil	European Aluminium Association (2018) *Environmental Profile Report for the European Aluminium Industry* CE Delft (2007) *Environmental Indices for the Dutch Packaging Tax* DESNZ (2024) *GHG Conversion factors* Environment Agency (2010) Waste and Resources Assessment Tool for the Environment (WRATE)
Steel Cans	World Steel Association (2021) *Life cycle inventory (LCI) study 2020 data release* World Steel Association (2022) *Worldsteel LCA eco-profile Tinplate* DESNZ (2024) *GHG Conversion factors* Swiss Packaging Institute (1997) *BUWAL* Environment Agency (2010) *Waste and Resources Assessment Tool for the Environment (WRATE)*
Mixed Cans	Estimate based on aluminium and steel data, combined with data returns from Courtauld Commitment retailers (confidential, unpublished)

Material	Reference
Glass	Ecoinvent 3 (2024) *Packaging glass production, white*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Packaging glass production, green*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Packaging glass production, brown*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Packaging glass production, white, without cullet*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Packaging glass production, green, without cullet*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Packaging glass production, brown, without cullet*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Market for glass cullet, sorted*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Market for packaging glass, white*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Market for packaging glass, green*, Swiss Centre for Life Cycle Inventories Glass raw material emissions for virgin glass are based on “without cullet” data, while emissions for recycled material are based on solving for emissions based on Packaging Glass production and production without cullet, accounting for the proportion of virgin and secondary material in the Packaging glass production inventories. Glass forming emissions are derived by comparison of Glass Packaging production emissions with Market emissions.

Material	Reference
Wood	Pöyry Forest Industry Consulting Ltd and Oxford Economics Ltd (2009) *Wood Waste Market in UK* DESNZ (2024) *GHG Conversion factors* Environment Agency (2010) *Waste and Resources Assessment Tool for the Environment (WRATE)* Ecoinvent 3 (2024) *Sawnwood, beam, softwood, dried (u=20%), planed {CH}| market for sawnwood, beam, softwood, dried (u=20%), planed | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Particleboard, uncoated {RER}| particle board production, uncoated, average glue mix | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Plywood, for indoor use {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Oriented strand board {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Medium density fibreboard {RER}| medium density fibreboard production, uncoated | Cut-off, S*, Swiss Centre for Life Cycle Inventories
Aggregates	WRAP (2008) *Lifecycle Assessment of Aggregates*
Paper and board	CPI (2019) *The economic value of the UK paper-based industries 2019*, CPI DESNZ (2024) *Company GHG Reporting Guidelines*, DESNZ Ecoinvent 3 (2024) *Corrugated board box {RER} | production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Deinked pulp, wet lap {RoW}| treatment of waste paper to pulp, wet lap, totally chlorine free bleached | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Folding boxboard carton {RER} |folding boxboard carton production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Paper, newsprint {RER} | paper production, newsprint, virgin | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Paper, newsprint {RER} | paper production, newsprint, recycled | Cut-off, S*, Swiss Centre for Life Cycle Inventories FEFCO (2018) *European database for Corrugated Board Life Cycle Studies*, FEFCO FEFCO (Accessed 2/4/2024) *Circular by Design* (webpage), FEFCO WRAP (2020) *Compositional analysis of Local Authority collected and non-Local Authority collected non-household municipal waste (England)*, WRAP
Books	Estimate based on paper

Material	Reference
Scrap Metal	British Metals Recycling Association (website[43]) Ecoinvent (2020) copper production, cathode, solvent extraction and electrowinning process Giurco, D., Stewart, M., Suljada, T., and Petrie, J., (2006) Copper Recycling Alternatives: An Environmental Analysis
Electrical goods	Ecoinvent (2020) market for computer, desktop, without screen Ecoinvent (2020) market for computer, laptop Ecoinvent (2020) market for dishwasher Ecoinvent (2020) market for dryer Ecoinvent (2020) market for electric kettle Ecoinvent (2020) market for hair dryer Ecoinvent (2020) market for microwave oven production Ecoinvent (2020) market for printer, laser, colour Ecoinvent (2020) market for refrigerator Ecoinvent (2020) battery cell production, Li-ion Ecoinvent (2020) battery production, NiMH, rechargeable, prismatic Hamade R., Al Ayache, R., Bou Ghanem, M. and Ammouri, A. (2020) “Life Cycle Analysis of AA Alkaline Batteries”, *Procedia Manufacturing*, 4: 415–22
Food and Drink	Tassou, S, Hadawey, A, Ge, Y and Marriot, D (2008) *FO405 Greenhouse Gas Impacts of Food Retailing* DEFRA and ONS (2009) *Family food and expenditure survey* DECC (2013) *Energy consumption in the UK*
Compost (food and garden)	Boldrin, A., Hartling, K., Laugen, M. and Christensen, T (2010) *"Environmental inventory modelling of the use of compost and peat in growth media preparation"*

[43] https://www.recyclemetals.org/about-metal-recycling.html.

Material	Reference
Plastics	AMA Research (2009) *Plastics Recycling Market UK 2009-2013*, UK; Cheltenham DESNZ (2024) *Company GHG Reporting Guidelines*, DESNZ Ecoinvent 3 (2024) *Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Packaging film, low density polyethylene {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}| polyethylene terephthalate production, granulate, amorphous, recycled | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyethylene terephthalate, granulate, bottle grade {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyethylene, high density, granulate {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyethylene, high density, granulate, recycled {Europe without Switzerland}| polyethylene production, high density, granulate, recycled | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polystyrene, expandable {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polystyrene, high impact {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyvinylchloride, bulk polymerised {RER}| polyvinylchloride production, bulk polymerisation | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyvinylchloride, emulsion polymerised {RER}| polyvinylchloride production, emulsion polymerisation | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Polyvinylchloride, suspension polymerised {RER}| polyvinylchloride production, suspension polymerisation | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Stretch blow moulding {RER}| production | Cut-off, S*, Swiss Centre for Life Cycle Inventories Ecoinvent 3 (2024) *Thermoforming, with calendering {RER}| thermoforming, with calendering | Cut-off, S*, Swiss Centre for Life Cycle Inventories Environment Agency (2010) *Waste and Resources Assessment Tool for the Environment (WRATE)* WRAP (2006) *UK plastics waste: A review of supplies for recycling, global market demand, future trends and associated risks*, WRAP WRAP (2008) *LCA of Mixed Waste Plastic Recovery Options*, WRAP

Material	Reference
Clothing	BIO IS (2009) *Environmental Improvement Potentials of Textiles (IMPRO-Textiles)*, EU Joint Research Commission
Mineral Oil	IFEU (2005) *Ecological and energetic assessment of re-refining used oils to base oils: Substitution of primarily produced base oils including semi-synthetic and synthetic compounds; GEIR*
Plasterboard	WRAP (2008) *Life Cycle Assessment of Plasterboard*, prepared by ERM; WRAP; Banbury
Concrete	Ecoinvent 3 (2024) *Concrete, normal {GLO}*| *market group for concrete, normal* | *Cut-off, S*, Swiss Centre for Life Cycle Inventories WRAP (2008) *LCA of Aggregates*, Banbury: WRAP
Bricks	Environment Agency (2011) *Carbon Calculator* USEPA (2003) *Background Document for Life-Cycle Greenhouse Gas Conversion factors for Clay Brick Reuse and Concrete Recycling* Christopher Koroneos, Aris Dompros, "*Environmental assessment of brick production in Greece"*, Building and Environment, Volume 42, Issue 5, May 2007, Pages 2114-2123
Asphalt	Aggregain (2010) *CO_2 calculator* Mineral Products Association (2011) *Sustainable Development Report*
Asbestos	Swiss Centre for Life Cycle Inventories (2014) Ecoinvent v3.0
Insulation	Hammond, G.P. and Jones (2008) "*Embodied Energy and Carbon in Construction Materials*" Proceeding of the Institution of Civil Engineers WRAP (2008) *Recycling of Mineral Wool Composite Panels into New Raw Materials*

1.6 Greenhouse Gas Conversion factors

Table 1.3 Greenhouse gas conversion factors

Industrial Designation or Common Name	Chemical Formula	Radiative Efficiency (Wm^{-2} ppb^{-1})	Lifetime (years)	Global Warming Potential with 100 year time horizon (previous estimates for 1st IPCC assessment report)	Possible source of emissions
Carbon dioxide	CO_2	1.4×10^{-5}	Variable	1	Combustion of fossil fuels
Methane	CH_4	3.7×10^{-4}	12	28 (23)	Decomposition of biodegradable material, enteric emissions.
Nitrous Oxide	N_2O	3.03×10^{-3}	114	265 (296)	N_2O arises from Stationary Sources, mobile sources, manure, soil management and agricultural residue burning, sewage, combustion and bunker fuels
Sulphur hexafluoride	SF_6	0.52	3200	22,800 (22,200)	Leakage from electricity substations, magnesium smelters, some consumer goods
HFC 134a (R134a refrigerant)	CH_2FCF_3	0.16	14	1,430 (1,300)	Substitution of ozone depleting substances, refrigerant manufacture / leaks, aerosols, transmission and distribution of electricity.
Dichlorodifluoro-methane CFC 12 (R12 refrigerant)	CCl_2F_2	0.32	100	10,900	
Difluoromono-chloromethane HCFC 22 (R22 refrigerant)	$CHClF_2$	0.2	12	1,810	

No single lifetime can be determined for carbon dioxide because of the difference in timescales associated with long and short cycle biogenic carbon. For a calculation of lifetimes and a full list of greenhouse gases and their global warming potentials please see Table 2.14: Lifetimes, radiative efficiencies and direct (except for CH_4) global warming potentials (GWP) relative to CO_2 (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Avery, M. Tignor and H.L. Miller, 2007).

Appendix 2. Updated full time series – Electricity and Heat and Steam Factors

The tables below provide the fully updated and consistent time series data for electricity, heat and steam emission factors. This is provided for organisations wishing to use fully consistent time series data for purposes OTHER than for company reporting (e.g. policy analysis).

Table 1.4 Base electricity generation emissions data – most recent datasets for time series

Data Year	Electricity Generation (1)	Total Grid Losses (2)	UK electricity generation emissions (3), ktonne		
	GWh	%	CO_2	CH_4	N_2O
1990	280,236	**8.08%**	205,989	2.952	3.742
1991	283,203	**8.27%**	202,565	2.777	3.685
1992	281,225	**7.55%**	190,578	2.642	3.462
1993	284,352	**7.17%**	174,149	2.614	2.952
1994	289,128	**9.57%**	169,714	2.728	2.817
1995	299,197	**9.07%**	166,758	2.758	2.705
1996	313,072	**8.40%**	166,801	2.799	2.528
1997	311,220	**7.79%**	154,260	2.706	2.178
1998	320,740	**8.40%**	158,904	2.858	2.239
1999	323,871	**8.25%**	151,161	2.933	1.963
2000	331,553	**8.38%**	163,415	3.143	2.197
2001	342,686	**8.56%**	173,895	3.439	2.419
2002	342,339	**8.26%**	168,493	3.371	2.280
2003	354,223	**8.47%**	180,848	3.596	2.502
2004	349,312	**8.71%**	178,826	3.581	2.426
2005	350,778	**7.25%**	177,038	4.174	2.564
2006	349,211	**7.21%**	185,935	4.262	2.769
2007	352,778	**7.34%**	183,783	4.354	2.583
2008	348,876	**7.43%**	179,127	4.695	2.453
2009	338,983	**7.86%**	157,806	4.613	2.124
2010	344,127	**7.38%**	162,771	4.804	2.226
2011	329,792	**7.91%**	150,155	4.806	2.236
2012	324,823	**8.00%**	164,335	5.287	2.838
2013	318,753	**7.57%**	151,847	5.629	2.715
2014	298,064	**8.11%**	127,780	6.446	2.359

Data Year	Electricity Generation [1]	Total Grid Losses [2]	UK electricity generation emissions [3], ktonne		
	GWh	%	CO_2	CH_4	N_2O
2015	297,520	**8.30%**	107,572	7.738	2.168
2016	296,952	**7.80%**	85,387	8.094	1.523
2017	293,680	**8.15%**	74,731	8.082	1.396
2018	289,079	**8.05%**	68,175	9.070	1.445
2019	282,958	**8.23%**	61,463	10.065	1.431
2020	270,254	**8.73%**	52,557	10.094	1.416
2021	268,361	**8.46%**	58,102	10.866	1.527
2022	282,962	**8.87%**	57,565	9.838	1.377
2023	251,641	**9.49%**	46,974	9.657	1.327

Notes:

(1) Based upon calculated **total** for **all** electricity generation (GWh supplied) from DUKES (DESNZ, 2024) Table 5.5, with a reduction of the total for autogenerators based on unpublished data from the DESNZ DUKES team on the share of this that is actually exported to the grid.

(2) Based upon calculated net grid losses from data in DUKES (DESNZ, 2024) Table 5.1.2 (long term trends, only available online).

(3) Emissions from UK centralised power generation (excluding Crown Dependencies and Overseas Territories) listed under UNFCC reporting category 1A1a and autogeneration - exported to grid (UK Only) listed under UNFCC reporting category 1A2b and 1A2gviii from the UK Greenhouse Gas Inventory for 2023 (Ricardo, 2025). Also includes an accounting (estimate) for autogeneration emissions not specifically split out in the UK GHGI, consistent with the inclusion of the GWh supply for these elements also.

Table 1.5 Base electricity generation conversion factors (excluding imported electricity) – fully consistent time series dataset

Data Year	Emission Factor, kgCO2e / kWh												% Net Electricity Imports
	For electricity GENERATED (supplied to the grid)				Due to grid transmission /distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	TOTAL
1990	0.73505	0.00029	0.00354	0.73889	0.06458	0.00003	0.00031	0.06492	0.79964	0.00032	0.00385	0.80381	**4.08%**
1991	0.71526	0.00027	0.00345	0.71899	0.06448	0.00002	0.00031	0.06482	0.77975	0.00030	0.00376	0.78381	**5.48%**
1992	0.67767	0.00026	0.00326	0.68120	0.05532	0.00002	0.00027	0.05560	0.73299	0.00028	0.00353	0.73680	**5.60%**
1993	0.61244	0.00026	0.00275	0.61545	0.04730	0.00002	0.00021	0.04753	0.65974	0.00028	0.00296	0.66298	**5.55%**
1994	0.58698	0.00026	0.00258	0.58983	0.06214	0.00003	0.00027	0.06244	0.64913	0.00029	0.00286	0.65227	**5.52%**
1995	0.55735	0.00026	0.00240	0.56000	0.05560	0.00003	0.00024	0.05587	0.61295	0.00028	0.00264	0.61587	**5.26%**
1996	0.53279	0.00025	0.00214	0.53518	0.04888	0.00002	0.00020	0.04910	0.58167	0.00027	0.00234	0.58427	**5.08%**
1997	0.49566	0.00024	0.00185	0.49776	0.04190	0.00002	0.00016	0.04207	0.53756	0.00026	0.00201	0.53983	**5.06%**
1998	0.49543	0.00025	0.00185	0.49753	0.04541	0.00002	0.00017	0.04560	0.54083	0.00027	0.00202	0.54313	**3.74%**
1999	0.46673	0.00025	0.00161	0.46859	0.04197	0.00002	0.00014	0.04214	0.50871	0.00028	0.00175	0.51073	**4.21%**
2000	0.49288	0.00027	0.00176	0.49490	0.04511	0.00002	0.00016	0.04529	0.53798	0.00029	0.00192	0.54019	**4.10%**
2001	0.50745	0.00028	0.00187	0.50960	0.04751	0.00003	0.00018	0.04771	0.55496	0.00031	0.00205	0.55731	**2.95%**
2002	0.49218	0.00028	0.00176	0.49422	0.04429	0.00002	0.00016	0.04447	0.53647	0.00030	0.00192	0.53869	**2.40%**
2003	0.51055	0.00028	0.00187	0.51270	0.04724	0.00003	0.00017	0.04744	0.55778	0.00031	0.00204	0.56014	**0.61%**
2004	0.51194	0.00029	0.00184	0.51407	0.04884	0.00003	0.00018	0.04905	0.56078	0.00031	0.00202	0.56311	**2.10%**
2005	0.50470	0.00033	0.00194	0.50697	0.03942	0.00003	0.00015	0.03960	0.54412	0.00036	0.00209	0.54657	**2.32%**
2006	0.53244	0.00034	0.00210	0.53489	0.04140	0.00003	0.00016	0.04159	0.57384	0.00037	0.00226	0.57648	**2.11%**
2007	0.52096	0.00035	0.00194	0.52325	0.04125	0.00003	0.00015	0.04143	0.56221	0.00037	0.00209	0.56468	**1.46%**
2008	0.51344	0.00038	0.00186	0.51568	0.04121	0.00003	0.00015	0.04139	0.55465	0.00041	0.00201	0.55707	**3.06%**
2009	0.46553	0.00038	0.00166	0.46757	0.03970	0.00003	0.00014	0.03988	0.50523	0.00041	0.00180	0.50745	**0.84%**
2010	0.47300	0.00039	0.00171	0.47510	0.03768	0.00003	0.00014	0.03785	0.51068	0.00042	0.00185	0.51295	**0.77%**

Data Year	Emission Factor, kgCO_2e / kWh												% Net Electricity Imports
	For electricity GENERATED (supplied to the grid)				Due to grid transmission /distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	TOTAL
2011	0.45530	0.00041	0.00180	0.45751	0.03910	0.00004	0.00015	0.03929	0.49441	0.00044	0.00195	0.49680	**1.85%**
2012	0.50592	0.00046	0.00232	0.50869	0.04398	0.00004	0.00020	0.04422	0.54990	0.00050	0.00252	0.55291	**3.52%**
2013	0.47638	0.00049	0.00226	0.47913	0.03899	0.00004	0.00018	0.03922	0.51537	0.00053	0.00244	0.51834	**4.33%**
2014	0.42870	0.00061	0.00210	0.43140	0.03786	0.00005	0.00019	0.03810	0.46656	0.00066	0.00228	0.46950	**6.44%**
2015	0.36156	0.00073	0.00193	0.36422	0.03274	0.00007	0.00017	0.03298	0.39430	0.00079	0.00211	0.39720	**6.62%**
2016	0.28755	0.00076	0.00136	0.28967	0.02432	0.00006	0.00011	0.02450	0.31187	0.00083	0.00147	0.31417	**5.64%**
2017	0.25446	0.00077	0.00126	0.25649	0.02257	0.00007	0.00011	0.02275	0.27703	0.00084	0.00137	0.27924	**4.79%**
2018	0.23584	0.00088	0.00132	0.23804	0.02066	0.00008	0.00012	0.02085	0.25649	0.00096	0.00144	0.25889	**6.20%**
2019	0.21722	0.00100	0.00134	0.21955	0.01948	0.00009	0.00012	0.01968	0.23669	0.00109	0.00146	0.23924	**6.96%**
2020	0.19447	0.00105	0.00139	0.19691	0.01860	0.00010	0.00013	0.01883	0.21307	0.00115	0.00152	0.21574	**6.22%**
2021	0.21651	0.00113	0.00151	0.21915	0.02002	0.00010	0.00014	0.02026	0.23653	0.00124	0.00165	0.23941	**8.40%**
2022	0.20344	0.00097	0.00129	0.20570	0.01979	0.00009	0.00013	0.02001	0.22323	0.00107	0.00142	0.22571	**0.00%**
2023	0.18667	0.00107	0.00140	0.18914	0.01958	0.00011	0.00015	0.01984	0.20625	0.00119	0.00154	0.20898	**8.65%**

Notes: * The updated 2016 (2014 update year) methodology uses data on the contribution of electricity from the different interconnects, hence these figures are based on a weighted average emission factor of the conversion factors for France, the Netherlands, Ireland, Belgium, and Norway based on the % share supplied.

The dataset above uses the most recent, consistent data sources across the entire time series.

Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) / (1 - %Electricity Total Grid LOSSES)

Emission Factor (Electricity LOSSES) = Emission Factor (Electricity CONSUMED) - Emission Factor (Electricity GENERATED)

⇒ Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) + Emission Factor (Electricity LOSSES)[44]

[44] Slight differences in the CONSUMED figure shown in the table and the figure which can be calculated using the Emission Factor (Electricity GENERATED) + Emission Factor (Electricity LOSSES) in the table is due to rounding. The CONSUMED figure in the table is considered to be more accurate.

Table 1.6 Base electricity generation emissions factors (including imported electricity) – fully consistent time series dataset

Data Year	Emission Factor, $kgCO_2e$ / kWh												% Net Electricity Imports
	For electricity GENERATED (supplied to the grid, plus imports)				Due to grid transmission /distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	TOTAL
1990	0.70970	0.00028	0.00341	0.71339	0.06236	0.00002	0.00030	0.06268	0.77206	0.00030	0.00372	0.77608	**4.08%**
1991	0.68309	0.00026	0.00329	0.68664	0.06158	0.00002	0.00029	0.06190	0.74467	0.00028	0.00358	0.74853	**5.48%**
1992	0.64536	0.00025	0.00310	0.64871	0.05268	0.00002	0.00026	0.05296	0.69804	0.00027	0.00336	0.70167	**5.60%**
1993	0.58222	0.00025	0.00261	0.58508	0.04496	0.00002	0.00020	0.04519	0.62718	0.00027	0.00282	0.63027	**5.55%**
1994	0.55840	0.00025	0.00245	0.56110	0.05911	0.00002	0.00026	0.05939	0.61751	0.00027	0.00271	0.62049	**5.52%**
1995	0.53215	0.00025	0.00229	0.53468	0.05309	0.00002	0.00023	0.05334	0.58524	0.00027	0.00252	0.58803	**5.26%**
1996	0.50989	0.00024	0.00205	0.51217	0.04678	0.00002	0.00019	0.04699	0.55667	0.00026	0.00223	0.55916	**5.08%**
1997	0.47442	0.00024	0.00178	0.47643	0.04010	0.00002	0.00015	0.04027	0.51452	0.00026	0.00193	0.51671	**5.06%**
1998	0.48082	0.00025	0.00180	0.48286	0.04407	0.00002	0.00017	0.04426	0.52489	0.00027	0.00197	0.52712	**3.74%**
1999	0.45088	0.00025	0.00155	0.45267	0.04055	0.00002	0.00014	0.04071	0.49143	0.00027	0.00169	0.49339	**4.21%**
2000	0.47600	0.00026	0.00170	0.47796	0.04356	0.00002	0.00015	0.04373	0.51956	0.00028	0.00185	0.52169	**4.10%**
2001	0.49449	0.00027	0.00182	0.49658	0.04630	0.00002	0.00017	0.04649	0.54079	0.00029	0.00199	0.54307	**2.95%**
2002	0.48208	0.00027	0.00173	0.48407	0.04338	0.00002	0.00015	0.04355	0.52546	0.00029	0.00188	0.52763	**2.40%**
2003	0.50796	0.00028	0.00186	0.51010	0.04700	0.00002	0.00017	0.04719	0.55496	0.00030	0.00203	0.55729	**0.61%**
2004	0.50271	0.00028	0.00181	0.50480	0.04796	0.00002	0.00017	0.04815	0.55067	0.00030	0.00197	0.55295	**2.10%**
2005	0.49497	0.00032	0.00190	0.49720	0.03866	0.00002	0.00015	0.03883	0.53363	0.00035	0.00205	0.53603	**2.32%**
2006	0.52286	0.00034	0.00206	0.52526	0.04066	0.00002	0.00016	0.04084	0.56352	0.00036	0.00222	0.56610	**2.11%**
2007	0.51455	0.00034	0.00191	0.51680	0.04075	0.00002	0.00015	0.04092	0.55530	0.00036	0.00206	0.55772	**1.46%**
2008	0.50010	0.00037	0.00181	0.50228	0.04014	0.00003	0.00014	0.04032	0.54024	0.00040	0.00196	0.54260	**3.06%**
2009	0.46234	0.00038	0.00165	0.46437	0.03943	0.00003	0.00014	0.03961	0.50177	0.00041	0.00179	0.50397	**0.84%**
2010	0.47002	0.00039	0.00171	0.47212	0.03744	0.00003	0.00013	0.03761	0.50746	0.00043	0.00184	0.50973	**0.77%**
2011	0.45001	0.00040	0.00178	0.45219	0.03865	0.00003	0.00015	0.03883	0.48866	0.00044	0.00193	0.49103	**1.85%**

Data Year	Emission Factor, kgCO2e / kWh												% Net Electricity Imports
	For electricity GENERATED (supplied to the grid, plus imports)				Due to grid transmission /distribution LOSSES				For electricity CONSUMED (includes grid losses)				
	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	CO_2	CH_4	N_2O	Total	TOTAL
2012	0.49718	0.00045	0.00228	0.49990	0.04322	0.00003	0.00020	0.04345	0.54040	0.00048	0.00247	0.54335	**3.52%**
2013	0.46546	0.00048	0.00221	0.46815	0.03810	0.00004	0.00018	0.03832	0.50356	0.00053	0.00238	0.50647	**4.33%**
2014	0.41407	0.00058	0.00203	0.41668	0.03657	0.00006	0.00018	0.03680	0.45064	0.00064	0.00221	0.45348	**6.44%**
2015	0.35250	0.00071	0.00189	0.35509	0.03192	0.00007	0.00017	0.03216	0.38442	0.00077	0.00205	0.38725	**6.62%**
2016	0.28577	0.00076	0.00135	0.28788	0.02417	0.00007	0.00012	0.02435	0.30994	0.00083	0.00147	0.31224	**5.64%**
2017	0.25473	0.00077	0.00126	0.25677	0.02259	0.00007	0.00012	0.02277	0.27732	0.00084	0.00138	0.27954	**4.79%**
2018	0.23148	0.00086	0.00130	0.23364	0.02028	0.00008	0.00012	0.02047	0.25176	0.00094	0.00141	0.25411	**6.20%**
2019	0.21284	0.00097	0.00132	0.21513	0.01908	0.00009	0.00012	0.01929	0.23192	0.00106	0.00143	0.23442	**6.96%**
2020	0.19057	0.00103	0.00136	0.19296	0.01822	0.00010	0.00013	0.01845	0.20879	0.00113	0.00149	0.21142	**6.22%**
2021	0.20664	0.00109	0.00144	0.20917	0.01911	0.00010	0.00013	0.01934	0.22575	0.00119	0.00157	0.22851	**8.40%**
2022	0.20344	0.00097	0.00129	0.20570	0.01979	0.00009	0.00012	0.02000	0.22323	0.00106	0.00141	0.22571	**0.00%**
2023	0.17489	0.00101	0.00131	0.17721	0.01834	0.00010	0.00013	0.01857	0.19323	0.00111	0.00144	0.19578	**8.65%**

Notes: * The updated 2016 methodology uses data on the contribution of electricity from the different interconnects, hence these figures are based on a weighted average emission factor of the conversion factors for France, the Netherlands, Ireland, Belgium, and Norway, based on the % share supplied.

The dataset above uses the most recent, consistent data sources across the entire time series.

Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) / (1 - %Electricity Total Grid LOSSES)

Emission Factor (Electricity LOSSES) = Emission Factor (Electricity CONSUMED) - Emission Factor (Electricity GENERATED)

⇒ Emission Factor (Electricity CONSUMED) = Emission Factor (Electricity GENERATED) + Emission Factor (Electricity LOSSES

Table 1.7 Fully consistent time series for the heat/steam and supplied power carbon factors as calculated using DUKES method

Data Year	$kgCO_2$/kWh supplied heat/steam	$kgCO_2$/kWh supplied power
	Method 1 (DUKES: 2/3rd - 1/3rd)	Method 1 (DUKES: 2/3rd - 1/3rd)
2001	0.238	0.478
2002	0.230	0.457
2003	0.234	0.469
2004	0.228	0.454
2005	0.221	0.439
2006	0.231	0.459
2007	0.231	0.461
2008	0.224	0.447
2009	0.222	0.440
2010	0.219	0.431
2011	0.215	0.511
2012	0.205	0.398
2013	0.208	0.407
2014	0.202	0.400
2015	0.196	0.392
2016	0.186	0.374
2017	0.174	0.353
2018	0.173	0.345
2019	0.174	0.338
2020	0.178	0.343
2021	0.184	0.354
2022	0.176	0.338
2023	0.174	0.332

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